



IMPLEMENTATION OF AN INNOVATIVE PHARMACEUTICAL CURRICULUM: ANALYSIS OF THE IMPACT ON READINESS FOR PHARMACY PROFESSION

**De Implementatie van een Innovatieve Farmaceutische Opleiding:
Analyse van de Impact op de Startbekwaamheden van de Apotheker**



Sofie Timmers

Pharmacist

Thesis submitted to obtain the degree of
Doctor in Pharmaceutical Sciences

Proefschrift voorgedragen tot het bekomen van de graad van
Doctor in de Farmaceutische Wetenschappen

2009

Dean:

Prof. dr. apr. Jean-Paul Remon

Promotors:

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ACKNOWLEDGEMENTS

“Hoe begin je hieraan?” en “Ik moet zien dat ik niemand vergeet...” Dit zijn zinnen, die al een tijdje in mijn hoofd ronddwalen. Een goed dankwoord schrijven is niet gemakkelijk, maar wel één van de, althans voor mij, belangrijkste stukken in dit schrijfwerk.

Weeral een stap verder...

En dit zou ik in de eerste plaats niet bereikt hebben zonder mijn twee ‘coaches’. Professor Baeyens, u zorgde mee voor de menselijke sfeer op ons labo. Dankjewel om ons onze eigen weg te laten gaan en ons op een zelfstandige manier te laten werken onder uw toezicht. Ook mag ik niet vergeten dat u diegene bent geweest, die een assistent-plaats heeft ‘afgestaan’ om aan onderwijskundig onderzoek te kunnen doen. Zonder deze kans had ik dit onderzoekswerk nooit kunnen vervolledigen. Professor Valcke, u wil ik uiteraard bedanken voor uw deskundige begeleiding. Uw enthousiasme heeft me telkens opnieuw gemotiveerd om verder te gaan. U hebt ook een heel professionele groep medewerkers op de dienst Onderwijskunde, bij wie ik steeds terecht kon. Bram, Hilde en Tammy dankjewel voor de tips en het geduld.

Professor Remon en Professor Nelis zou ik ook willen bedanken voor het feit dat zij, als decaan en als onderwijsdirecteur, de nodige aandacht aan het onderwijs besteed hebben en dit nog steeds doen. Ik heb mij altijd gesteund gevoeld om verder te doen met dit toch ietwat ‘aparte’ onderzoek.

Op ons labo was ik het buitenbeentje of de ‘eenoo’, om het met professor Baeyens zijn woorden te zeggen. Toch heb ik het altijd fijn gevonden om met de analytici samen te werken en heb ik veel bijgeleerd over Process Analytical Technology. In het bijzonder wil ik Thomas bedanken voor de fijne momenten tijdens het geven van practica aan de studenten, maar ook voor de vriendschappelijke babbels en de steun. Thomas, ik wens je nog heel veel succes in de toekomst! Claudine, dankjewel voor de fijne babbeltjes tijdens mijn koffiepauzes (Wat zouden we vanavond eten?), de steun en de praktische beslommingen. Pieter, jij gaat binnenkort andere oorden opzoeken. Het ga je goed! Anneleen, jij bent er het laatst bijgekomen. Ondertussen hebben wij al anderhalf jaar een bureau gedeeld en elke ochtend is het weer fijn om te arriveren op het werk. Dankjewel voor de vele aangename momenten, je luisterend oor en je verhalen. Ik wens je nog veel succes toe, geef de moed niet op ondanks het feit dat de toestellen niet altijd mee willen. Ann en

Tineke, jullie werken ondertussen niet meer bij ons, maar jullie hebben er wel mee voor gezorgd dat ik me in de eerste jaren op het FFW vlug heb kunnen thuisvoelen (en veel heb kunnen lachen). Ik wens jullie alle geluk toe, vooral met de kindjes.

Nadia, Vera, Anita, Francine en Ann, jullie wil ik ook bedanken om me tijdens de eerste jaren onmiddellijk op te nemen in de groep. Jullie hebben ervoor gezorgd dat het niet lang geduurd heeft voor ik mijn draai gevonden had op het werk. Ondanks het feit dat we elkaar nu minder kunnen zien, geniet ik nog altijd van mijn sporadische bezoeken aan de andere kant van de gang.

Inge, Leen, Els, Koen en Charlotte, jullie mogen in dit dankwoord zeker niet ontbreken. We hebben al regelmatig moeten samenwerken en zullen dat in de toekomst nog moeten doen. Inge, jou ken ik al het langste. Van in het begin mocht ik regelmatig met jou overleggen over onze laatstejaarsstudenten. Dankjewel voor de vlotte manier van werken en ook voor de interesse in de vooruitgang van mijn onderzoek. Hier aan de faculteit mag men blij zijn met zo'n stageverantwoordelijke! Els en Leen, de laatste jaren hebben we elkaar professioneel veel gezien en gehoord. Het voorbereiden en het geven van de lessen in het kader van het OTC-project waren voor mij heel leerrijk, maar tegelijk ook aangenaam. Dit was toch wel het bewijs dat wij samen goed probleemoplossend kunnen denken, niet? Leen, nog veel succes met je werk en geniet maar van je kindjes want voor je weet... Els, jij hebt gekozen om je terug op het onderzoek te storten. Ik wens je veel succes, maar besef dat men een heel bekwaam iemand minder heeft om zich aan de farmaceutische zorg te wijden. Koen, jij hebt de fakkel van Els overgenomen en je hebt dat tot nu toe al heel goed gedaan. De samenwerking met jou is wel nog pril, maar ik besef nu al dat dat allemaal vlot zal lopen. Ik kijk er al naar uit... Charlotte, jou wil ik bedanken voor de vlotte samenwerking gedurende de laatste twee jaren wat betreft het opstellen van de casussen m.b.t. senioren, en ook voor het begrip.

De mensen van het FSA, Tamara en Anneleen, mag ik ook niet vergeten te bedanken voor het altijd, zonder morren, geven van alle studentgegevens. Ik denk dat jullie blij zijn dat ik (voorlopig) geen 'puntenbriefjes' meer nodig heb.

Het opstellen van de patiëntcasussen en het evalueren van de studenten is gedurende twee en een half jaar ook vlotter verlopen door de hulp van een medewerker. Marijke, dankjewel voor je tijd, moeite en inzet om dit tot een goed einde te brengen.

Al mijn collega's van op het tweede ('de bureu') wil ik bedanken voor de vele gezellige en vooral plezante momenten. Jullie zorgen ervoor dat het aangenaam werken is. Hoe het gekomen is, kan ik me niet meer herinneren, maar ineens was het er en sindsdien heb ik het gevoel dat ik er echt bij hoor en dat ik een beetje deel uitmaak van jullie labo. Ine, jouw relativiseringsvermogen en jouw wijsheid hebben me al vaak met mijn twee voeten op de grond gezet en hebben me ook al veel geleerd. Ik ben echt blij dat jij nog op het FFW blijft werken zodat we samen nog veel kunnen kletsen over ons gezin, ons huis enz... Ik wens je nog veel succes tijdens je laatste maanden van je zwangerschap en uiteraard ook een vlotte bevalling en een heel gezond kindje. Bart (Lucas), dankjewel voor je grenzeloze bereidheid om iedereen te helpen, je bent echt een onvervangbare collega hier op het tweede. Ook wil ik je via deze weg bedanken voor het 'babysitten' tijdens de zaterdagnamiddagen waarop Arnoutje jou mocht komen 'helpen' met de diertjes. Hij kijkt al uit naar een volgende afspraak! Koen, Bart (Geers), Nathalie, Kevin B., Dries, Marie-Luce, Broes, Hendrik, Geertrui, Oliwia, Chaobo, Kevin Br., Zanna, Joanna, Katrien, Bruno en Katharine, jullie wil ik bedanken voor de vriendelijke gezichten, de vele lachmomenten, de plagerijen, kortom het plezier dat ik samen met jullie al gehad heb. Ik heb het ongeloofelijk getroffen dat ik op het tweede terecht gekomen ben, hopelijk blijft de sfeer nog lang zo, het is alleszins iets om fier op te zijn.

Tinneke en Elien, ik weet het is (te) lang geleden, maar toch ben ik onze sportieve badmintonmomenten nog niet vergeten. Elien, hopelijk kunnen we de draad (of beter gezegd het pluimpje) binnenkort terug opnemen.

Roos, Stefaan en Lies, jullie hebben sinds een tijdje een andere werkstek gevonden. Ik heb jullie al veel gemist, maar ben blij dat we nog steeds contact hebben. Roos, ik heb altijd naar jouw wetenschappelijk inzicht en jouw onderzoekermentaliteit opgekeken. Ik ben er zeker van dat jij het nog ver gaat brengen en ik wens je dan ook heel veel succes toe! Stefaan, jij bent een echte levensgenieter, maar ook een heel fijn iemand om te kennen. Dankjewel voor de interesse, die je steeds opnieuw toonde, en de fijne babbels. Lies, ik heb te weinig plaats en tijd om alles op te sommen waarvoor ik je wil bedanken. Maar het allerbelangrijkste is jouw onvoorwaardelijke vriendschap. Dankjewel dat ik die heb mogen ervaren, vooral in de toch wel moeilijke maanden, die ik gekend heb. Hier zou ik je even willen citeren "ons verhaal eindigt hier nog niet..."

Ook mag ik mijn thesisstudenten niet vergeten te vermelden. Filip, Wilhelm, Marie-Hélène, Ben, Céline, Kaatje, Aline, Trui, Anneleen, Sarah, Julie, Laure, Heleen, Sien en Liesbeth, dankjewel voor de samenwerking. Door jullie te begeleiden heb ook ik elk jaar opnieuw weer wat bijgeleerd. Kaatje, Trui, Anneleen, Julie, Sarah en Laure wil ik in het bijzonder bedanken voor het helpen coderen

van de berichten. Dat was geen prettig werkje, maar jullie hebben het toch tot een goed einde gebracht.

Veerle en Kathleen, we wonen allemaal ver van elkaar, maar ik wil jullie toch bedanken voor de vele telefoontjes, de blikken van interesse en de vriendschap.

Els, Lieve, Leen, Nathalie, Ilse en Lily, dankjewel om ons uit de nood te helpen met de opvang van de kindjes. Het is fijn om in Zwijnaarde al zoveel mensen te kennen waarop we kunnen rekenen.

Mama en papa, jullie hebben me mijn eigen keuze laten maken, hoewel dit niet de meest voor-de-hand-liggende was. Dankjewel! Maar wat ik jullie vooral wilde zeggen: ik bewonder jullie enorm. Dat jullie over een grote dosis doorzettingsvermogen beschikken, hebben jullie in het laatste moeilijke jaar eens te meer bewezen. Ik kan alleen maar hopen dat ik dat van jullie geërfd heb. Papa en mama, ik hoop dat we na de vele regen van het voorbije jaar, weer snel zon krijgen. Jullie verdienen het. Maar ik besef wel dat ik ook iets geleerd heb in deze periode. Ik heb nog meer leren relativeren en leren genieten van de kleine dingen in het leven. Of hoe een slechte gebeurtenis toch nog goede gevolgen kan hebben...

Ook wil ik mijn kindjes, Arnout en Lore, bedanken voor de vele mooie momenten, de fijne en afwisselende 'pauzes' en de liefde die ik van hen krijg. En last but not least, chouke, jij hebt me de laatste maanden echt laten voelen wat het is om een 'steun en toeverlaat' te hebben. Het is een heel grote geruststelling om juist in moeilijke periodes iemand te hebben waar je altijd op kan rekenen. Dankjewel voor alles!

SOFIE

Gent, juni 2009

LIST OF ABBREVIATIONS

| | |
|------------------|---|
| ANOVA | Analysis of Variance |
| BaMa | Bachelor-Master |
| CSCL(E) | Computer Supported Collaborative Learning (Environment) |
| CSLE | Computer Supported Learning Environment |
| DAC | Division of Analytical Chemistry |
| EAFP | European Association of Faculties of Pharmacy |
| ECTS | European Credit Transfer System |
| FECS | Federation of European Chemical Societies |
| GIPKS | Group Integrated Pharmaceutical Knowledge Score |
| GLKC | Group Level of Knowledge Construction |
| GP | General Practitioner |
| ICS | Integrated Curriculum Score |
| ICT | Information and Communication Technology |
| IES | Internship Experience Scale |
| ILKC | Individual Level of Knowledge Construction |
| IMS | Individual Message Score |
| INFOADMIN | Information and Administration |
| INFO PROF | Professional Information |
| IPC | Integrated Pharmaceutical Curriculum |
| IPK | Integrated Pharmaceutical Knowledge |
| IprKnS | Individual Prior Knowledge Score |
| IRS | Individual Role Score |
| LAW_DEON | Law and Deontology |
| LKC | Level of Knowledge Construction |
| LLL | Life Long Learning |
| LSD | Least-significant Difference |
| MAGPREP | Magistral Preparations |
| ORG | Organisation (in a professional pharmacy) |
| OTC | Over the Counter |
| PBL | Problem Based Learning |
| PC | Pharmaceutical Care |
| PRES | Prescriptions (medical) |
| RR | Response Rate |
| SPEC | Medicines, Drugs |
| SPSS | Statistical Package for Social Sciences |
| TBL | Task Based Learning |

Chapter 1

GENERAL INTRODUCTION

General Introduction

The critical state-of-the-art in pharmacy education.

“Tell me and I forget. Teach me and I remember. Involve me and I learn.”

(Benjamin Franklin, °1706-†1790)

This quote is a perfect description of what we hope to achieve by implementing new educational techniques in the training of Pharmaceutical Sciences. One of the questions of this dissertation is how to design, develop and integrate modern educational technologies in general, and in particular a new course in the last year of the curriculum to stimulate and support learning of all last year's students. The research presented in this dissertation will give an explanation of the development of this new course in the curriculum of Pharmaceutical Sciences at Ghent University and if and how this course, together with the other educational renewals, has an impact on the newly graduated pharmacists to get them better prepared for their professional career.

Before giving a detailed account of the curriculum innovation at the Faculty of Pharmaceutical Sciences of Ghent University, we discuss the multifarious reasons that necessitated the innovation.

REASONS OF INTERNATIONAL EDUCATIONAL ADAPTATIONS

THE BOLOGNA DECLARATION (1999)

For the last ten years, higher education in general and pharmaceutical education in particular has struggled with lots of changes. These changes affected both the content and the structure of higher education. Next to macro-level issues (such as the Bachelor Master introduction, the ECTS system, ...), also meso-level (programme level) and micro-level issues can be observed. An example of the latter is the integration and implementation of new Information and Communication Technologies (ICT) in the curriculum and daily teaching and learning practices. All these issues reflect the impact of the rapidly changing society where graduated students have to start their professional life, by the current economy that is based on exchange of knowledge and information, by the

increasing importance of internationalisation and last but not least by the adaptations of construction of higher education as mentioned in the Bologna declaration.

It is important for Higher Education to model all-round students who can cope with these changes. It is obvious that not only their knowledge base will be strengthened, but also that they adopt skills that embrace the idea of lifelong learning (LLL), of being communicative and being able to collaborate. Health care practitioners, for example pharmacists, should continuously update their competences. This calls for continuing professional development. Training these skills will have to start while they are being educated in the Higher Education setting. This has caused an important paradigm shift in Pharmaceutical Education: a shift from a rather drug oriented education to a rather patient centred education with the student at the centre of the educational processes.

As mentioned above, one of the most obvious reasons of changing higher education at the Ghent University was the signing of The Bologna Declaration (June 1999). This is a declaration on the European space for higher education and it was signed at first by 29 countries, including Belgium, to coordinate their educational policies. The implementation of the Bachelor-Master structure (BaMa-structure), one of the most important features, caused a major revolution all over Europe. This revolution tried to fill the gap between the unification of the internal European market (since 1992) and the dominant national nature of qualification and graduation structures in higher education. At last, the necessity for uniformisation of the latter was recognized. The adaptations proposed in the Bologna Declaration reflected commitments of each of the signatory countries to reform and adjust their national higher education system, and to create a largely converging European higher education space. Most European countries chose to implement the changes in a gradual way, but in Flanders (the Dutch speaking area of Belgium), the educational authorities opted for a *big-bang* implementation, a major overall transformation of all curricula in higher education. The advantage of this comprehensive approach is that it prevents that some institutions go ahead and others stay behind (Van Damme, 2004).

Since the Ghent University adopts a high profile and high quality standards, the introduction of the Bachelor-Master structure was carefully set up and monitored. But next to structural changes of the curricula, there was also a need to reconsider the instructional models being in place. Although Ghent University is qualified as a “campus university” that invests strongly in face-to-face education, there was a strong willingness to exploit fully the possibilities offered by the information and communication technology (ICT). This greatly enhanced the accessibility of higher education, next to supporting the face-to-face teaching by adopting a blended learning model. As a result, at the

Ghent University, ICT is strongly implemented and used as a supplement to traditional educational approaches, but not as a replacement. In addition, Ghent University has chosen for a de-central approach to implement educational innovations, allowing the faculties to develop ideas and solutions that fit the particularities of their curriculum (Onderwijsontwikkelingsplan Universiteit Gent, 2003).

According to the new educational point of view of the Ghent University, the innovative instructional approaches imply that learning should be an active process, not a passive process based on listening and looking. To stimulate this active process, students should be given the chance to collaborate; they should be involved in a broader range of instructional opportunities such as guided self-instruction, permanent evaluation and self-evaluation. These new instructional forms are essential to develop necessary academic and professional experiences as a basis to develop new theoretical and research insights. The students will be stimulated to adopt this active learning mode by using new educational technologies and the possibilities offered by ICT. The latter is considered a good preparation for lifelong learning, self-organisation and time management. Students should learn how to take responsibility of their own learning processes, to be able to implement their acquired knowledge and skills in their professional life (Onderwijsontwikkelingsplan Universiteit Gent, 2003).

THE CHANGING ROLE OF A PHARMACIST: *Pharmaceutical Care*

During the last decade the role of a pharmacist changed tremendously. Nowadays, a pharmacist not only needs to know which drug is to be chosen for a given disease, he/she should also be aware of the growing need of a constant dialogue with patients. The role of today's pharmacist has evolved from a rather drug-oriented to that of a more patient-oriented one (Dietrich, 2006).

In an environment where the big department stores also want to sell non-prescribed medicines (over-the-counter medicines, OTC), it is important that pharmacists can live up to their excess value by showing their profound scientific knowledge and their critical mind about evaluation of the products.

"Pharmaceutical care" has become more important. A pharmacist in a community pharmacy has to manage and improve the patients' medication use. As pharmaceutical care is to result in better outcomes for drug therapy and reduced health care costs, it is important to implement this

new concept in a modern up-to-date pharmacy education curriculum (EAFP, 1999). However, pharmaceutical care is not only significant for the students but also for graduated pharmacists. The latter need further education to become “more complete” health care providers. Patients rely on practicing health care professionals, e.g., pharmacists, for important services; hence the latter carry increasing responsibilities. The newer generation of pharmacists should provide pharmaceutical care to the patients by keeping in mind their drug therapeutical needs, by identifying patient-specific drug therapy problems to be resolved, and/or prevented, and by building a patient-specific care plan in cooperation with the patients and their care providers. Every pharmacist is responsible for providing sufficient pharmaceutical care and for giving enough information and advice to the patients (Federal Agency for Medicines and Health Products, 2009). To provide this care in a satisfying manner a pharmacist should possess sufficient clinical knowledge and patient management skills (Dietrich, 2006). He/she also should be aware of the adequate channels and strategies to gather reliable information in a world where the media blind us with knowledge. This information is then to be communicated to the patients; therefore a pharmacist should possess good communicative skills (Hargie et al., 2000). Moreover, drug development occurs fast, and since chemical compounds are generally quite complicated, the pharmacist has to be well trained in the chemical and physiological disciplines. As to the patients, they are nowadays much more informed and emancipated, and hence expect their pharmacist to possess full knowledge of all areas concerning medicines and their chemistry, diseases and their physiology, botany, toxicology, to cite a few disciplines (Broedel-Zaugg et al., 2008).

THE INCREASING NEED FOR THE IMPLEMENTATION OF INFORMATION AND COMMUNICATION TECHNOLOGY FACILITIES IN EDUCATIONAL SETTINGS

In the last decade, society has evolved into an information society. People and students are loaded with information through lots of different media. Nowadays universities have a very important additional role to help students finding their way in this information and communication society. As a result, graduating students must be able to work with these new technologies, to deal with all the provided information, to remain objective and to filter good and reliable information. Graduates no longer are expected to digest and memorise large amounts of knowledge, but are expected to get access to this information and to cope with it in a professional way.

The Belgian and Flemish Governments have supported the academic world to adjust higher educational programmes to take up the challenges of the information society. There have been several large-scale initiatives to start up ICT-related innovative educational projects (STIHO, 1997-2002). This so called ICT policy is a stimulating policy to give the academic world in general and the institutes for higher education in particular the opportunity to integrate Information and Communication Technology in their educational settings. This policy of educational use of new media is built on five pillars: new infrastructure, support needed to guide all educational institutions to substantially change their traditional pedagogical approach, training of the new educational co-operators, internationalization and last but not least evaluation and research of the impact of the implementation of ICT.

The studies presented in this PhD fit into this last category of work.

SPECIFIC REASONS THAT ADVANCED EDUCATIONAL ADAPTATIONS IN THE PHARMACY CURRICULUM

THE VISITATION COMMISSION REPORT

Next to the Bologna declaration as mentioned above, and the changes of the job profile of a pharmacist in today's society, the innovation of the curriculum was also furthered by the outcomes of the 2003 Visitation Commission. The Visitation committee is an external board that plays a critical role in a seven-year external quality review cycle. The report of this external board recommended a number of educational innovations to be adopted in the curriculum. One of the most significant recommendations was the implementation of more active instructional approaches in the final years of the curriculum (Rapport Visitatiecommissie, 2003).

The report also recommended to update the undergraduate curriculum in view of developing an attitude of lifelong learning. Instructional formats should be adopted to stimulate students to acquire knowledge independently. Initiatives to work from an interdisciplinary perspective and to introduce problem-based learning should be stimulated and extended, again especially in the final years of the pharmaceutical curriculum (Rapport Visitatiecommissie, 2003).

The Visitation commission was pleased to observe certain innovations and especially to see the adoption of new educational techniques. However, more activating and integrated educational

reforms should be promoted. This also involved stimulating students to develop more communicative, ICT- and research skills. Within this scope, the commission recommended to work in a systematic way by first putting down goals and final attainment levels, and next to develop new educational format and courses (Rapport Visitatiecommissie, 2003).

A major outcome of this recommendation was the redesign of the final internship and the development and implementation of a course focusing on Integrated Pharmaceutical Knowledge for last year's students.

DEVELOPING BETTER SUPPORT AND GUIDANCE DURING INTERNSHIP IN THE LAST YEAR OF THE PHARMACEUTICAL CURRICULUM.

At the Ghent University pharmacy students have to fulfil 26 weeks of internship in a pharmacy which is open to the public or in a hospital, under the supervision of that hospital's pharmaceutical department (European Parlement, 2005). They can choose to do a few weeks after the third Bachelor year, but the greatest part of the traineeship is fulfilled during the second semester of the last year of the curriculum.

Academic education does not only provide students with basic or more profound theoretical knowledge. Educational formats especially aim at providing students with sufficient feedback in relation to their learning processes. This is also the case in relation to internships. In the past, internship students working in a community or a hospital pharmacy were rather left on their own or could only relate to their internship supervisors. These pharmacy supervisors developed an evaluation report about student performance during his/her internship period (Remon and Van Tongelen, 2004). But this did not allow university staff to foster the further educational development during these 26 weeks of internship and there was little possibility to provide feedback to the students.

Working with a computer-supported learning environment could potentially fill in this gap. ICT presents an advantage from the tutors' point of view, since this would re-establish the possibilities of university to be involved more intensely in the internship. University staff can in this way - independently from time and space - monitor and guide the work of the students and can provide feedback and adjustments where and when needed. The implementation of computer-

supported learning (CSL) will enhance the communication possibilities with and among students; and the risk of being isolated will decrease.

CRITICAL SKILLS AND KNOWLEDGE FOR ENTRY-TO-PRACTICE STUDENTS AND INTERNSHIP PHARMACY SUPERVISORS

Last but not least, an additional reason to develop the innovative course in the last year of the pharmaceutical curriculum was the fact that students, internship supervisors, professors and other academic staff members experienced the feeling that something was missing in the curriculum. Although students received enough theoretical courses and practice opportunities, they were hardly able to go beyond the borders of each individual course. However this is exactly what a pharmacist is expected to do when looking at a patient or dealing with a pharmaceutical problem. Students should integrate their knowledge base to be able to deal with real-life situations.

Considering the preceding points, it is now clear what the motives were behind the design and development of the new course for last year's students and the implementation of new instructional strategies. In the next part of this general introduction, we discuss the design and development of the course "Integrated Pharmaceutical Knowledge" (IPK). At the same time we will describe in detail the research questions and the structure of the research reported in this doctoral thesis.

DESIGN AND DEVELOPMENT OF THE COURSE "INTEGRATED PHARMACEUTICAL KNOWLEDGE"

To design and develop a new course combining a variety of educational methodologies such as face-to-face discussions and computer-supported collaborative learning (CSCL), it is important to keep in mind critical success factors. In this context, we can also build on evidence-based practices to direct design and development decisions. These elements are listed and discussed below: learning objectives, task-type, group size and computer support (Strijbos et al., 2004).

NEW LEARNING OBJECTIVES AND THE DESIGN AND DEVELOPMENT OF THE IPK COURSE

As already mentioned, the role of the today's pharmacist has changed during the last decade from a drug-oriented role to a patient-oriented role. In Flanders, Belgium, the different Faculties of Pharmacy (Antwerp, Leuven, Brussels and Ghent) joined forces in 2002 to develop an answer to these new needs in terms of an updated curriculum for pharmacy students. It became clear that it was necessary to go beyond basic scientific and pharmaceutical knowledge during undergraduate education. This does not question the relevance of a profound theoretical base. The innovative curriculum should anyhow put a large emphasis on the development of the grounding knowledge base and the necessary skills. A group of representatives of the different Faculties of Pharmacy concluded that the curriculum needed especially an upgrade in view of better preparing entry-to-practice students during their last year of study. The curriculum innovation aimed at preparing them better for their professional life by a strong emphasis on the integrated nature of domain specific knowledge in the context of real-life situations, from a multidisciplinary perspective and while integrating patient care knowledge. The latter resulted in a list of new learning objectives. In the next stage, each specific faculty designed and developed an educational environment to pursue these new educational objectives.

At the Faculty of Pharmaceutical Sciences of Ghent University, it was decided to develop a completely new course for the last year's students, called originally 'Integrated Medicines Knowledge' but later rebaptized as 'Integrated Pharmaceutical Knowledge' (IPK). Although the IPK course was not the only initiative being taken in view of the pharmacy curriculum innovation, it was the only completely new course being developed for entry-to-practice students. The IPK course does not only reflect new contents, but is also new as to the instructional techniques being adopted. Since pharmacists and other health care practitioners have adopted computer technologies in order to manage and find information concerning medicines, diseases, pharmaceutical care, and to communicate more effectively within and across health disciplines (Gardner and Evans, 2004; Westerlund et al., 2007), the potential of the information and communication technology (ICT) should also be part of the educational innovation.

Next to the decision for designing the IPK course taken at the end of the academic year 2002-2003, it was also decided to closely monitor and evaluate the impact of the curriculum innovation. It is in this context that the present PhD research was set up to analyse the impact on students' readiness for professional life. The results of the different evaluative studies are reported in the present dissertation.

April 2003

A survey, called the Internship Experience Scale (IES), was designed in view of monitoring the redefined goals of the pharmacy internship (Remon and Van Tongelen, 2004) and the updated final attainment levels of the pharmacy education curriculum at Ghent University (Final Attainment Levels after Introducing Bachelor-Master Structure, Faculty of Pharmaceutical Sciences, Ghent University, 2002). Administration of the IES instrument was expected to provide the faculty with adequate information about the students' readiness for their internship and their professional life in a (community) pharmacy. In April 2003 the IES instrument was presented for the first time to last year's students. This was at the same time the actual start of a series of educational evaluation studies. The design and development of the IES is described in more detail in Chapter 2.

The Academic year 2003-2004

The development of the course IPK started at the end of 2003. Building on the literature presenting empirical evidence about the merits of case-based education (Bresnitz et al., 1992; Peplow, 1992; Scott, 1994), it was decided to develop a series of cases, especially patient cases. Cases were worked out in co-operation with all professors of the Faculty of Pharmaceutical Sciences and some faculty members of the Faculty of Medicine and Health Care Sciences. An example of such a case is presented in Figure 1.

Patient case

The wife of a patient of 68 years enters the pharmacy with a medical prescription that says Augmentin® 500.

She tells the pharmacist that her husband, when he was having the flu, started to cough increasingly with accompanying abundant rust-coloured sputum, chest pain, high fever and shortness of breath.

The physician in charge diagnosed based on the described symptoms pneumonia and prescribed Augmentin® 500.

Figure 1. Presentation of one of the first theoretical patient cases.

Faculty members fully realised that the development of patient cases and related pharmaceutical problems and questions had the potential to deal – in an integrated way - with a broad set of pharmaceutical and medical subjects. Nevertheless, the development of such cases is very time-consuming and posed a problem both in relation to the timing of the IPK course and to the content of the case that will be far too theoretical and maybe even unrealistic when designed by scientists, not daily involved in pharmacy life.

Since the curriculum of last year's students is heavily loaded with their internship and a number of obligatory and optional courses, there was insufficient time to programme another additional face-to-face course. But building on the possibilities offered by ICT, and asynchronous discussions, a valuable alternative was available to replace face-to-face classroom education in the context of the IPK course. In the literature, a variety of different examples is described that build on the use of asynchronous technologies in health science education (Kassam et al., 2003; Johnson et al., 2003; Rutter and Hunt, 2003).

The academic year 2004-2005

As mentioned earlier, there was a time management and content designing problem to develop a sufficient number of patient cases. This gave rise to the idea to ask individual students to develop patient cases during their internship. Students were invited to choose a case from their internship setting which they believed to be interesting for analysis from an interdisciplinary perspective. They were also invited to analyse what other curriculum subjects were needed to fully describe, understand and solve the patient case. By giving this assignment, students got the opportunity to work independently and to adopt a problem-solving attitude. On the other hand, this also resulted in a database of realistic patient cases that could be used in view of the next version of the IPK course. Also in the new version of IPK course, the assignment to develop some individual cases is still a part of the internship tasks. After all these years, we have as such been able to build up a database of hundreds of rich and realistic cases.

During the academic year 2004-2005, five patient cases were presented via an on-line forum to the students as part of the experimental version of the IPK course. Students got two weeks time per case to develop shared solutions for the pharmaceutical problems related to the cases in an asynchronous discussion environment. The on-line environment was developed in close collaboration with the Department of Educational Studies of the Faculty of Psychology and Educational Sciences. In the research literature, there is empirical evidence as to the importance of


assigning roles to students during asynchronous discussions (Schellens et al., 2005) . Therefore, it was decided to develop a related educational and research design. This helped to evaluate the impact of asynchronous discussions and role assignment on the level of knowledge construction and the related acquisition of integrated pharmaceutical knowledge. In addition, we also evaluated the differential impact of the nature and content of the patient cases, since the pharmaceutical nature of the cases was considered an interesting factor. The research setting, research design, and the results of this study are described in Chapter 4.

The academic years 2005-2006 and 2006-2007

From the start of the academic year 2005-2006, IPK became an official part of the pharmaceutical curriculum at Ghent University. Since the results of the evaluative research (see above) revealed that there was a significant positive impact of both role assignment and the pharmaceutical nature and content of the patient cases, it was decided to permanently integrate role assignment in future tasks and to pay intensive attention to the content of the patient cases and related problems. The importance of the content of the IPK course in general and the patient cases in particular made it clear that the overall content of the course has to be completely renewed every year. The amount of cases was decreased to 4 since the students were complaining about the high workload of this integrated course. Students were presented with 25 questions per case and had to work during at least two weeks on a patient case to find a shared group solution.

Deel 1

Een man van 50 jaar komt in de apotheek met onderstaand voorschrift. Hij vertelt dat de arts hem zopas meegedeeld heeft dat hij diabetes mellitus type II heeft. Zowel zijn moeder als broer zijn diabetes-patiënten. De man vraagt ook een bloedglucosemeter.

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| GENEESMIDDELENVOORSCHRIFT | | |

- I. Welke bloedglucosemeter levert u af en waarom? Welk advies geeft u aan deze man in verband met het meten van bloedglucose?
- II. Wat zijn de normale waarden voor bloedglucose? Vanaf welke waarden spreekt men van diabetes? Welke medische parameters worden nog onderzocht bij vermoeden van diabetes?
- III. Bij deze patiënt werd diabetes mellitus type II vastgesteld. Hoe weet men aan welk type diabetes een patiënt lijdt en wat zijn juist de verschillen tussen de verschillende types?
- IV. Welk advies geeft u aan de man omtrent de toediening van het voorgeschreven geneesmiddel? Denk eraan dat hij voor de eerste maal dit geneesmiddel komt halen.
- V. Communiceren is niet noodzakelijk overtuigen, maar overtuigen is een vorm van communiceren. Waarom is in de relatie diabetespatiënt-apotheker communicatie zo belangrijk?

Figure 2. Presentation of one of the integrated patient cases.

From the academic year 2005-2006 on, the Ghent University implemented an institution wide electronic learning environment, Claroline (nowadays called Minerva). This presented a convenient opportunity for faculties to upgrade their educational approaches. The IPK course is now integrated and presented via this e-learning environment by building on the integrated asynchronous discussion forums.

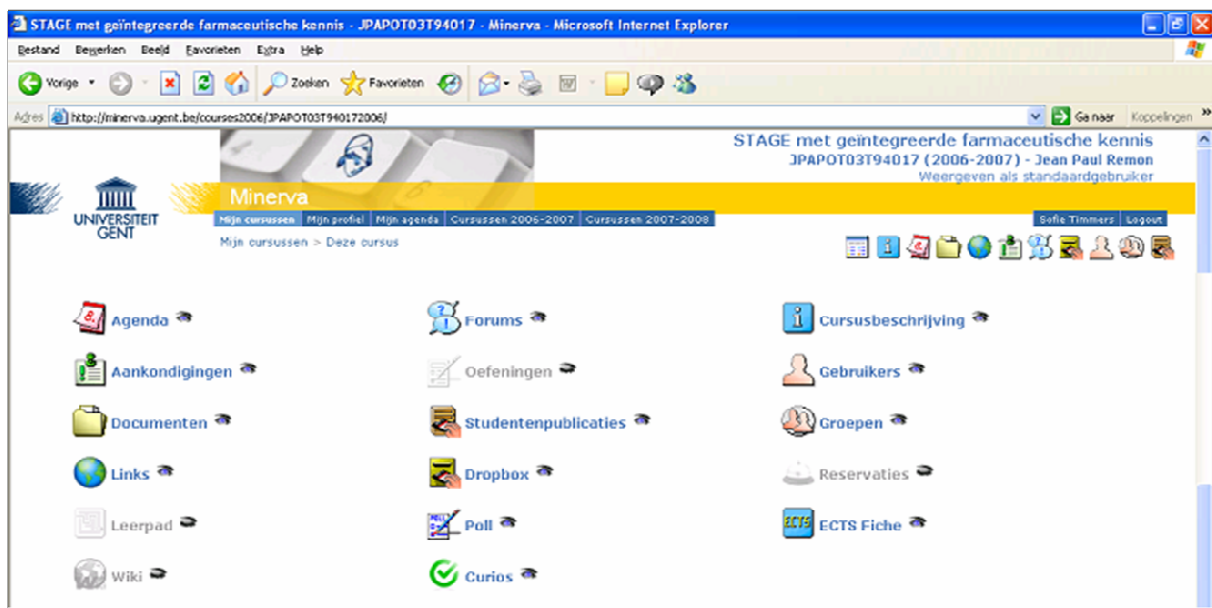


Figure 3. Screenshots of the e-learning environment Minerva of Ghent University.

Despite all the possibilities to activate students via the electronic learning environment, we nevertheless noticed that some students had problems with integrated thinking. They experienced difficulties to integrate their previously acquired knowledge in the context of a particular case or problem. Therefore it was decided – in view of the IPK course - to expand the on-line forums during the second semester with face-to-face discussions at the start of the academic year. During these face-to-face discussions, students are presented an exemplary patient case they have to discuss in a face-to-face group setting. During five integrative seminars, they get the opportunity to work together and discuss the case from different points of view under supervision of an expert. After these 5 weeks they have to hand in a report concerning the case, with the answers to the pharmaceutical questions. These face-to-face discussions allowed students to get to know each other better and to become familiar with the integrated and interdisciplinary thinking that is expected from them during the asynchronous discussions. In Figure 2, we present the general time table of this updated version of the IPK course.

Integrated Pharmaceutical Knowledge – Academic yearplan

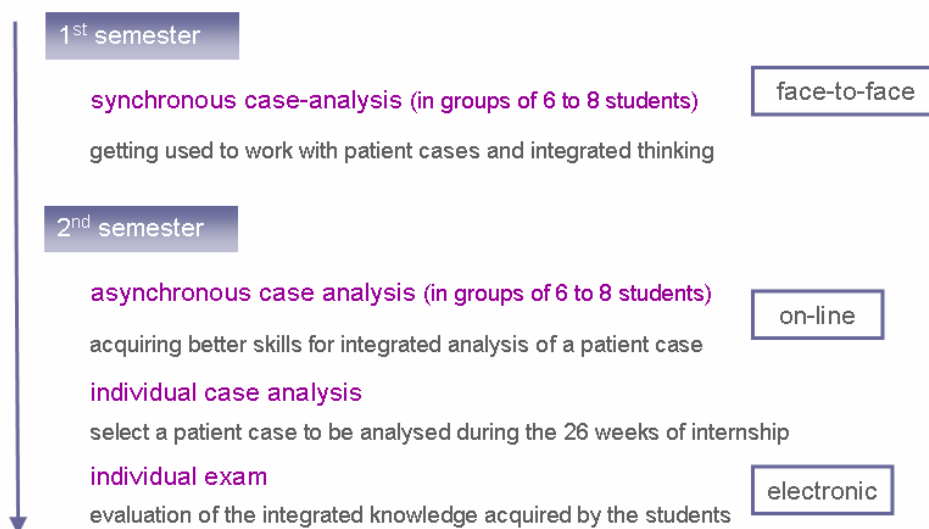


Figure 4. A general timetable of the course IPK since the academic year 2005-2006.

As can be observed in Figure 2, the evaluation of the IPK course is an important part of the course. Next to the permanent evaluation during the integrative face-to-face seminars, and during the asynchronous on-line discussions (see feedback forum 'Computer Support'), the course ends with a final individual assessment. The periodic evaluation of the face-to-face discussions is based on their

final report. The evaluation of the on-line discussions is based on the analysis of their contributions to discuss the patient cases and to solve the related questions. The final assessment is based on an electronic exam taken at the end of the second semester, and consisting of 50 interdisciplinary multiple choice questions.

The academic years 2007-2008 and 2008-2009

As described above, the IPK course became an official part of the pharmaceutical curriculum and only few changes have been made since then to the course design. First, we added a periodic evaluation moment after the face-to-face discussions at the end of the first semester. Second, since 2008, students do not only have to hand in a report concerning the patient case, but they also are expected to give an oral presentation to their fellow-students and give them the opportunity to discuss the proposed solutions for the pharmaceutical problems.

In this dissertation we only focus on the second and most important part of the course IPK, namely the impact of the on-line discussions via the computer supported learning environment. Nevertheless, for a full understanding of the overall impact of the IPK course, a complete description of the IPK course is useful.

GROUP SIZE

As can be derived from the research literature, giving students the opportunity to work in small collaborative groups, is stimulating to develop the communicative skills necessary for a pharmacist, and to achieve a problem solving attitude. Although literature is not unanimous as to the group size necessary to get the most of the collaboration (Strijbos, 2004; Veerman and Veldhuis-Diermanse, 2001), small groups, from 3 up to 8 students per group, seem to be favoured. This is also confirmed by recent empirical research (Valcke and Schellens, 2006). Therefore there was decided to work in groups of 6 to 8 students. Since most group work in the pharmacy curriculum builds on groups composed on the basis of alphabetical order, we decided to assign participants ad random to the collaborative groups. This helped to prevent a possible bias caused by earlier established communicative and collaborative attitudes in groups. It also forced the students to reconsider their communicative skills when working together with less familiar students.

COMPUTER SUPPORT

Working by means of a computer-supported collaborative learning environment makes it possible to activate student participation by giving direct feedback. This feedback can be given from a distance during the period of internship. An electronic network facilitates communication between the students, who are distributed in diverse community and hospital pharmacies, but also fosters the communication between the students and university staff. Students will thus feel less isolated and will be stimulated to work in group and to improve their communication skills. Students can share their questions, problems and opinions with their fellow-students but also with tutors and assistants from within the university.

To provide sufficient feedback to the students, a feedback forum was offered via the Minerva, e-learning environment of the Ghent University. Hence students could ask questions or give comments at any time. Supervisors from the university could monitor these questions and give feedback when needed. It is to be stressed that this feedback focused on participation, technical problems, and planning issues. In no case, the feedback forum was used to discuss the content of the patient cases or to provide extra content related or problem solving related stimuli. As such, it can be concluded that no uncontrolled mediating variable played a role during the asynchronous discussions.

CONCEPTUAL BASE OF IPK IN VIEW OF THE RESEARCH OF THIS DISSERTATION

As already mentioned, the Ghent University aimed at the innovation of its instructional approaches. Within this setting, the Faculty of Pharmaceutical Sciences implemented new educational technologies, adopted a problem-based learning approach from the third curriculum year on, and introduced a completely new course in the last year of the curriculum. The new IPK course starts from diverse pharmaceutical problems, related to presented patient cases. Students have to look for new information to find a solution for the problems and will have to develop new or reorganize available cognitive schemes by discussing the information with their fellow-students. This is an example of a task-based learning (TBL) setting, in which a real or simulated authentic setting is presented and the students are asked to apply their acquired knowledge to find a common solution for the problem. In the literature the principles of TBL have often been described as a relevant theoretical position in view of medical higher education (Harden et al., 1996 (a +b); O' Halloran, 2001). Since TBL involves action and reflection and refers to apply real life contexts, the efficacy of using it in a medical or pharmaceutical higher educational curriculum is evident (Harden et al., 1996 (a+b)). IPK works for a great part by means of a computer supported collaborative learning

environment (CSCL), in which on-line discussions take a central place. Other names for on-line discussions are computer mediated conferencing (CMC), computer mediated discussion (CMD), computer conferencing (CC), networked learning (NL) or asynchronous learning networks (ALN) (De Wever et al., 2006). As described by Whittington and Campbell (1998), on-line learning environments can be especially effective platforms to implement task-based learning.

The research in this dissertation mainly focusses on (1) the overall impact of the educational innovation in general at the Faculty of Pharmaceutical Sciences and (2) the differential impact of the CSCL in the context of the newly developed course IPK in the last year of the curriculum to influence students' readiness for professional life.

Working in a CSCL setting implies that students will communicate through written discussions about the presented patient cases and related pharmaceutical problems. As they propound their own viewpoints and opinions by discussing the problems, they will learn from each other (Gerlach, 1994). They get the chance to compare their knowledge, to negotiate and to come to a common conclusion. CSCL environments are most effective when the users point out their different views, solutions and opinions and dare to deal with them and exchange them (De Wever et al., 2002). By putting students in a collaborative learning environment - in the literature often referred to as a social constructive learning environment - students are stimulated to engage in self-guided, daring, active and reflective learning activities that result into efficient and effective learning (Schellens, 2004).

As the pharmacy students of the last year work at different locations during the last three months of their internship, it is a great advantage to be able to use on-line discussions that can be accessed independently from time and place.

RESEARCH SETTING

As the title of this dissertation implies, the present PhD-research was carried out in the context of the implementation of a set of innovations within the overall pharmaceutical curriculum and in the context of a newly developed IPK course in the final curriculum year. The main aim was to find out whether this innovation of pharmacy education had an impact on the readiness of the pharmacy students for their professional life. First, we focus on the design and development of an instrument, the Internship Experience Scale (IES), to monitor the impact on students' professional

readiness. The research especially centres on the psychometric qualities of the newly developed IES and therefore focuses on its validity and reliability.

The new IPK course is the most essential innovation for this dissertation. The IPK related research started in the academic year 2003-2004, when a first version of the course was designed and implemented. The following academic years, the redesign of the IPK course, was partly based on the research results gathered during the consecutive evaluation studies. As a result, this curriculum innovation has been studied and monitored during four successive academic years.

RESEARCH QUESTIONS (RQ)

In view of this investigation four fundamental research questions were formulated:

- RQ 1. Can we design and develop a valid and reliable instrument to monitor the impact of the implementation of the innovative course Integrated Pharmaceutical Knowledge (IPK) in the pharmacy education curriculum?
- RQ 2. What are the long term consequences of the implementation of the course IPK on the final attainment levels and the internship outcomes of entry-to-practice pharmacy students?
- RQ 3. Do role assignment and the nature of the pharmaceutical cases presented in the context of the IPK course via the CSCL environment, have a significant impact on the level of knowledge construction and on academic achievement of pharmacy students?
- RQ 4. Do individual student characteristics, e.g., gender, individual level of prior knowledge, individual amount of messages posted during the on-line discussions, and the individual role performance score, predict in a significant way the level of knowledge construction and academic achievement when working in a computer supported collaborative learning environment?

OVERVIEW OF THE DIFFERENT CHAPTERS

Chapter 2 reports on the research about the design and development of an instrument to monitor pharmacy students' readiness for professional life. The main scope is to find an answer to RQ 1.

The design and development of the instrument was based on one hand on the Internship Manual and the goals of internships in pharmacy (Remon and Van Tongelen, 2004), and on the other hand on the the final attainment levels of the new curriculum of Pharmaceutical Sciences (Final Attainment Levels after Introducing Bachelor-Master Structure, Faculty of Pharmaceutical Sciences, Ghent University, 2002). The newly developed instrument was labelled as the Internship Experience Scale (IES). In view of a sound use of the IES, the reliability, the content validity and the construct validity had to be determined. The latter was carried out by a factor analysis based on a principal component analysis.

In Chapter 3 a longitudinal investigation is described about the impact of the implementation of the innovative pharmacy education curriculum. This longitudinal study builds on the IES. In chapter 3, the answers to RQ 2 are presented in detail.

The IES was used to investigate whether the newly developed IPK course had a significant and consistent impact on attaining the final goals of the new pharmacy education. A cross-sectional and longitudinal approach was adopted by applying a repeated measures analysis (General Linear Model – analysis of variance). This will help to determine to what extent there are significant changes in the consecutive IES scores during four subsequent academic years. In addition, a pre- and post-IPK-test (t-test) analysis is helpful to detect on an annual basis the impact of the IPK course. Post-hoc analysis will be helpful to detect in what specific years changes in IES scores are significant.

Chapter 4 describes the results of a study that centres on the differential impact of assigning roles to students during the on-line-discussion, and the influence of the nature and content of the specific patient cases being discussed (RQ3).

The study investigates in particular whether role assignment during the on-line discussions and the pharmaceutical nature and content of the discussed patient cases have a significant impact on the achieved level of knowledge construction (LKC) and on the integrated pharmaceutical knowledge or the integrated curriculum score (ICS). The method of Veerman and Veldhuis-Diermanse (2001) was used to encode all the messages posted by the students during the on-line discussions and to determine in this way the specific level of knowledge construction.

Three hypotheses were put forward:

- Hypothesis 1: The pharmaceutical nature or content of the discussion case has a differential impact on the dependent variables: ICS and levels of knowledge construction.

- Hypothesis 2: Role assignment has a beneficial impact on the dependent variables. Groups that are asked to follow role assignments will attain significantly higher Integrated Curriculum Scores (ICS) and/or an average higher level of knowledge construction.
- Hypothesis 3: The nature of the role assigned to students will result in significant differences in ICS and/or the average level of knowledge construction.

The hypotheses were tested by carrying out an analysis of variance (ANOVA).

In Chapter 5 the research on the predictive value of individual student differences on the achievement of levels of knowledge construction and integrated pharmaceutical knowledge is described. The research about the predictive value of individual differences was carried out by applying multiple regression techniques. Since the relevant literature points to the potential impact of gender, this first student background variable was included in the study (Barbieri and Light, 1992; Dillenbourg et al., 1996; Whitelock and Scanlon, 1998; Light et al., 2000; Hakkarainen and Palonen, 2002). A second background variable is the individual level of prior knowledge. The choice for this variable builds on the available empirical evidence (Dochy, 1992; Moerkerke, 1996). However it should be mentioned that most studies in the field of prior knowledge were set up with novices, students who just started their academic career. In the present PhD, this variable is reconsidered but by involving advanced last-year's students.

Next to background variables, also a number of mediating variables have been incorporated in this study: individual amount of messages posted per case and the individual role performance score. The actual level of involvement in the CSCL setting is in this context considered as a critical variable for the expected outcomes.

The main issue of this research was to see if the mentioned individual predictive variables have an effect on the dependent variables, level of knowledge construction and level of integrated pharmaceutical knowledge, the latter can be described as the content score of the common group answers provided to the questions and pharmaceutical problems related to the presented patient cases during the on-line discussions.

Finally, Chapter 6 integrates the findings and results related to the research questions dealt with in the preceding chapters. In addition, we present a general discussion about the main objective of this dissertation, and the practical implications.

Besides a final conclusion, the limitations of the investigations are described together with recommendations for future research.

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Chapter 2

DESIGN AND DEVELOPMENT OF AN INSTRUMENT TO MEASURE INTERNSHIP READINESS OF LAST YEAR'S PHARMACY STUDENTS

This chapter is based upon '*Design and Development of an Instrument to Measure Internship Readiness of Last Year's Pharmacy Students*' (S. Timmers, W.R.G. Baeyens and M. Valcke), as submitted to *American Journal of Pharmaceutical Education* in 2009.

ABSTRACT

This article describes the design, development and use of an instrument to measure readiness for professional work in community or hospital pharmacies before and after the implementation of an innovative curriculum at the Faculty of Pharmaceutical Sciences of Ghent University. The instrument “Internship Experience Scale” (IES) was developed in the context of a large scale project to monitor the changes in curriculum content and in instructional techniques. In order to evaluate the quality of the curriculum reform, it was decided to centre on the entry-to-practice skills of last year’s students, and to what extent they feel prepared for the professional life in a pharmacy, mainly a community pharmacy.

Based on a cross sectional analysis of data obtained from five different cohorts of students in their final curriculum year, an extensive analysis of the psychometric quality of the IES was carried out. The results of the analysis point at a high reliability, good content validity and excellent construct validity. A first impression is given about the future potential of the IES to study student readiness considering the ongoing innovation of the pharmacy curriculum.

Chapter 2

Design and Development of an Instrument to Measure Internship Readiness of Last Year's Pharmacy Students

INTRODUCTION

In this article, we discuss the design, development and evaluation of an instrument to measure the professional readiness of students to function in a pharmacy, commonly a community pharmacy but also a hospital pharmacy. The challenge was to develop an instrument that helped to assess the competences of entry-to-practice students in a systematic, reliable and valid way.

The instrument is labelled the “Internship Experience Scale” (IES) and was developed to investigate the impact of a large scale curriculum innovation in pharmacy education. The new curriculum of Pharmaceutical Sciences implied firstly a reorientation at content level. This is exemplified by a stronger emphasis on practical relevance, contextualized learning, patient cases, practical tasks, and so forth. Next, the reorientation also implied the adoption of innovative instructional strategies that build on e.g., case-based learning, problem-based learning, task-oriented learning or collaborative learning. The latter is exemplified by new courses, such as the “Integrated Pharmaceutical Knowledge” (IPK) course and the reorganisation of the internship in the fifth year of the curriculum. In the next paragraphs we describe in more detail the different motives for the large scale curriculum reform: the Bologna Declaration and the reform of the pharmacy internship.

One of the challenges of universities these days is to exactly define the specific competences and skills that graduates need. Therefore major adaptations were required in the educational programme of Pharmaceutical Sciences of the Ghent University. Since the Bologna Declaration in

1999, the curriculum of a university study is expected to be structured according to an undergraduate or Bachelor programme and a postgraduate or Master programme. In the Belgian academic context, pharmacy education takes five years: a three-year Bachelor programme in Pharmaceutical Sciences, and a two-year programme to become a Master in Pharmaceutical Sciences (Pharmaceutical Care or Drug Development). The undersigning by Belgium of the Bologna Declaration implied that next to a restructuring of the curriculum, also the final attainment levels of the curriculum had to be updated. This resulted in a better definition of the specific competences and skills that graduates need at the end of the curriculum and a strong guideline that had to be taken into consideration when designing the IES (Final Attainment Levels after introducing Bachelor-Master structure, Faculty of Pharmaceutical Sciences, Ghent University, 2002).

Another consequence of the curriculum innovation was the revision of the internship goals. The Belgian system requires 26 weeks of internship for pharmacy students in a professional pharmacy, mostly a community pharmacy. Part of the internship (= 12 weeks) can be organised in the setting of a hospital pharmacy (Council of European Communities, 1985). At the Ghent University, pharmacy students fulfil the requirements for the internship in two phases. At the end of the third year, students are already involved in a few internship weeks during the summer months. However, the main part of the internship is completed during the second semester of the last curriculum year, starting in January and ending in May. The nature of the internship makes it difficult for university staff to monitor students and offer them sufficient and/or timely feedback since students are located at diverse places fulfilling their internship. A newly developed course, set up in parallel to the internship, tries to deal with these difficulties. This new course – labelled “Integrated Pharmaceutical Knowledge” (IPK) - is expected to contribute to the integration and application of the knowledge base acquired during the four preceding curriculum years. This new course requires the students – who are distributed over the country while taking their internship – to work together in small groups. The collaborative work is set up through a computer-supported collaborative learning environment (CSCLE). The on-line discussions build on real life patient cases. This requires students to build on their acquired knowledge in view of analysing the patient cases, the clinical situations and related pharmaceutical problems.

PROBLEM STATEMENT

Until recently, graduating students were not tested about their mastery of the integrated pharmaceutical knowledge, that is, about their ability to make connections between the different subjects treated in various courses. As a result, it was quite difficult to evaluate if students were sufficiently trained to start their professional career.

This raised questions. Such as: do there exist differences between the educational program as such and the requirements of professional life? This question was for instance reflected in complaints of internship tutors about the readiness of last year students. After five years of university education, have the curriculum goals sufficiently been achieved?

In addition, the potential impact of the implementation of an innovative curriculum cannot be underestimated. Therefore, in parallel to the development and implementation of this curriculum, an evaluation project was set up to monitor this process. This required the design, development and evaluation of a specific instrument to monitor the impact on student readiness for the pharmacy profession. The resulting instrument will allow an efficient evaluation of the education at the Faculty of Pharmaceutical Sciences of the Ghent University, and thus verifying whether the actual educational platform meets the new needs of professional pharmaceutical work.

This “Internship Experience Scale” (IES) should be sensitive enough to trace shortcomings in the educational curriculum, and to guide educational policy makers to redirect the curriculum by developing revised courses or by introducing new instructional approaches.

In the next sections of this chapter, we first describe the guiding principles and ideas in developing the IES. Next we focus on reporting the results of a study to determine the reliability and validity of the instrument.

THE PHARMACIST OF THE 21ST CENTURY

Amongst the major tasks of pharmacists are to be cited the responsible, safe and effective distribution of pharmacologically active substances. But nowadays, a pharmacist does not only need to know which drug is to be chosen for a given disease. He should also be aware of the growing need

of a constant dialogue with his patients. The role of a today's pharmacist has evolved from a rather *drug-oriented* to a more *patient-oriented* role (Dietrich, 2006).

Patients rely on practicing health care professionals such as pharmacists for receiving health services. The latter results in an increased responsibility for pharmacists. This requires them to be aware of legal and deontological issues related to their actions.

The former exemplifies the growing importance of *pharmaceutical care*, the keywords for the future of any pharmacist (Council of the International Pharmaceutical Federation, 1998). The new generation pharmacists should provide pharmaceutical care to the patients by keeping in mind their drug therapeutical needs, by identifying patient-specific drug therapy problems to be resolved and/or prevented and by building a patient-specific care plan in cooperation with the patients and their care providers. To provide this care in a satisfying manner, a pharmacist should possess sufficient clinical medical knowledge and patient management skills (Dietrich, 2006). He/she also should be aware of adequate sources and strategies to gather reliable information; such as the Internet, Web of Science, and so forth. This information is to be communicated to the patients; therefore a pharmacist should also possess good communicative and related educational skills (Hargie et al., 2000). Moreover, scientific drug development is a rapid and changing research area. The active chemical components of drugs are more and more complicated and requires pharmacists to be very well acquainted with the chemical and physiological disciplines. As to the patients, they are nowadays also better informed and emancipated, and hence expect their pharmacist to possess full knowledge of medicine, chemistry, diseases and their physiology, botany, toxicology, to mention but a few disciplines (Broedel-Zaugg et al., 2008).

The professional competences of entry-to-practice pharmacy students can – building on the above – be summarized as follows. Students should be able to understand the theoretical foundations of the profession, to apply the acquired scientific and statistical knowledge, to think critically and to make the right decisions, to communicate properly with patients, with other pharmacists and physicians, to effectively self-assess, to satisfy learning needs and to meld theory and abilities in the practice setting. Since the major educational task of universities is to prepare students for their professional life, they should not only adapt the content of the curriculum, but should also adopt appropriate instructional strategies that foster the development of student competences in view of future professional tasks and responsibilities in a modern pharmaceutical setting (Graber et al., 1999).

DESIGN AND DEVELOPMENT OF THE IES

The design of the “Internship Experience Scale” was inspired by the model of Bashook and Parboosingh (1998). These authors introduced competency-based assessment in medicine; this implies the definition of measurable elements of professional practice through a series of performance levels or indicators. Their instrument was to be filled in by medical doctors to obtain their recertification. By asking questions about their knowledge, their decision making skills and technical expertise, the test helped to determine whether they were capable to obtain their permission to practice medicine during the next seven years.

In the present research the instrument also gauges the readiness for professional life; but of last year's students. This group of students is an ideal target audience, since they passed already four years of studies and hence can optimally comment on their curriculum experience as to their readiness for professional life, especially in the context of the six months of internship in a pharmacy.

The construction of the instrument started from the available “Internship Manual” and the list of goals in view of pharmacy internships (Remon and Van Tongelen, 2004), combined with the final attainment levels of the curriculum of Pharmaceutical Sciences (Final Attainment Levels after Introducing Bachelor-Master Structure, Faculty of Pharmaceutical Sciences, Ghent University, 2002).

The starting point of scale development was discussions with pharmacists, more specifically supervisors of the internships. This revealed several points of interest as to what competences or goals were yet not mastered by entry-to-practice students. A team of content specialists developed clusters of statements. These statements focus on particular attainments, goals, or competences that were considered to be critical in view of professional activities in a pharmacy. Development of the statements was carried out during a number of cycles till all specialist agreed on the selection of statements and the structure of the instrument. A total of 53 statements were retained in the final test version of the instrument. Several clusters were defined. A first cluster concerns the organization of a pharmacy (7 statements). Secondly a large cluster centers on magistral preparations (13 statements). As suggested in the section about pharmaceutical care, also attention is paid to giving information to patients about pathology, medicines in general and pharmaceutical care in particular (9 statements). Knowledge about drugs and their side effects is central in the fourth cluster (7 statements). Since a pharmacist should be able to run a business and hire staff, he/she needs to be aware of related rules and obligations (4 statements). Pharmacists need to evaluate every medical prescription they have to carry out; therefore a cluster centres on prescriptions (8 statements). A

small cluster groups statements about staff and social matters (4 statements). Finally a cluster focuses on legislation and deontology (5 statements).

Students are required to indicate their level of agreement or disagreement with a statement on a 5-point Likert scale*. The scale ranges from 0 (amply sufficient) to 5 (very sufficient). Since it is possible that students – during an internship – did not get in touch with a particular problem of situation, they were also provided with the option “not relevant considering the nature of my internship”.

Organisation in a (community) pharmacy

I have got enough insight in the division of medicines and other products in a pharmacy during my higher education.

I have learned enough about the provisions for weekend and night service during my higher education.

I have learned enough about managing the stock during my higher education.

I have learned enough about the accountancy of a pharmacy during my higher education.

I have learned enough about contacting the wholesalers and representatives during my higher education.

I have learned enough about the purchasing policy during my higher education.

I have learned enough about the purchasing policy of raw materials for preparing magistral preparations during my higher education.

* Though Likert scales are considered to represent an ordinal scale, Likert himself presented this response pattern to obtain a distribution resembling a normal distribution (Likert, 1932). Especially when using the scale as a summated scale to produce an index, response patterns reflect easily normal distribution. If the nature of the latent variable being measured is of importance in this context. Clason & Dormody (1994, p.31) state : “Likert scaling presumes the existence of an underlying (or latent or natural) continuous variable whose value characterizes the respondents’ attitudes and opinions. If it were possible to measure the latent variable directly, the measurement scale would be, at best, an interval scale.” This is the case in the present study.

Magistral preparations

I have learned enough about controlling incompatibilities of a magistral preparation during my higher education.

I have got enough information about the existing literature concerning the making of and the problems related to magistral preparations during my higher education.

I have learned enough about the systematic way of dealing with a magistral preparation during my higher education.

I have learned enough about the choice of excipients of magistral preparations during my higher education.

I have learned enough about controlling the process of magistral preparations during my higher education.

I have learned enough about the choice of the right equipment for magistral preparations during my higher education.

I have learned enough about matching the right labels on magistral preparations during my higher education.

I have learned enough to make the right decision about packaging magistral preparations during my higher education.

I have learned enough about the legislation concerning labels on magistral preparations during my higher education.

I have learned enough about controlling a magistral preparation after being prepared during my higher education.

I have learned enough to calculate the price of magistral preparations during my higher education.

I have learned enough about controlling the dose of magistral preparations during my higher education.

I have learned enough about producing the right protocol for a magistral preparation during my higher education.

Information, Literature and Pharmaceutical Care

I have learned enough during my higher education about providing information concerning the literature that can be consulted.

I have learned enough about the identification of raw materials during my higher education.

I have learned enough during my higher education about the necessity of dedication for the interests of the profession of pharmacist.

I have learned enough about OTC-products during my higher education to adapt to the ways of self-medication of the patients.

I have learned enough about bandages and related materials for medical nursing during my higher education.

I have learned enough during my higher education to provide the patients with sufficient instructions and advice.

I have learned enough about "Pharmaceutical Care" during my higher education.

I have learned enough during my higher education about the value of further training courses and life-long learning.

I have learned enough during my higher education about the economic aspects of the professional pharmaceutical world.

Medicines

I have learned enough about the legislation of the different medicines during my higher education.

I have learned enough during my higher education about the interactions of the different medicines.

I have learned enough during my higher education about the indications of the different medicines.

I have learned enough about the toxicity of the different medicines during my higher education.

I have learned enough about the use of the different medicines during my higher education.

I have learned enough about the storage of the different medicines during my higher education.

I have learned enough about the side effects of the different medicines during my higher education.

Medical Prescriptions

I have learned enough during my higher education about controlling the administrative data of a prescription.

I have learned enough during my higher education about controlling the maximal dose of the medicines on a prescription.

I have learned enough during my higher education about controlling a prescription on instructions for use of medicines during my higher education.

I have learned enough during my higher education about controlling a prescription on incompatibilities.

I have learned enough about the legal regulations concerning prescriptions during my higher education.

I have learned enough about controlling a prescription on the dosages during my higher education.

I have learned enough during my higher education about the legal aspects concerning prescriptions.

I have learned enough during my higher education about controlling the delivery of prescribed medicines.

Staff Management

I have learned enough during my higher education about the administration in view of the staff.

I have learned enough during my higher education about the association with the division of labour in a pharmacy.

I have learned enough during my higher education about the deontology of relationships with colleagues.

I have learned enough during my higher education about the personnel policy.

Legislation and Deontology

I have learned enough during my higher education about the legal aspects concerning administration of narcotics.

I have learned enough during my higher education about the deontological relationship with doctors.

I have learned enough during my higher education about professional confidentiality and ethics.

I have learned enough during my higher education about the refund policy of medicines in our health care system.

I have learned enough during my higher education about social security and social legislation.

Figure 1. Presentation of the different item clusters of the IES.

VALIDITY AND RELIABILITY OF THE IES: RESEARCH APPROACH

A cross-sectional approach was adopted to determine the validity and reliability of the test version of the instrument. The test was administered in a systematic way to successive cohorts of students after their internship experience. Informed consent was obtained from all students. The study was approved by the ethical committee.

The IES statements were randomly presented to the students in order to avoid interference between items responses. A copy of the resulting “Internship Experience Scale” (IES) as presented to the students can be found in the Appendix.

The IES was presented to the students at the beginning of and again at the end of their last curriculum year. A time limit of 20 minutes of time was given to the students for filling out the instrument. It took an average of almost 12 minutes to fill in the 53 questions.

The IES was presented to five consecutive cohorts of last year pharmacy students. For benchmarking purposes, the IES was presented the first time to students who had not experienced the new curriculum and were not involved in the innovative course “Integrated Pharmaceutical Knowledge” (2002-2203). Subsequent to this, the instrument was filled in the four following academic years, 2003-2004, 2004-2005, 2005-2006 and 2006-2007.

In 2002-2003 and 2003-2004 a paper-and-pencil version of the test was administered to the students. The next student cohorts filled out the instrument via the electronic learning environment. This prevented potential bias, due to the presence of the researcher and resulted in a more efficient procedure to gather and process the data. Student responses were saved on a secured server. After filling in the instrument, a quality control cycle was performed to check whether all students fully completed the instrument. After linking a pre-test and post-test administration of the IES, personal student information was omitted from the data file to guarantee anonymity and confidentiality.

For the present study, all the data of the five cohorts were pooled and used in the subsequent psychometric quality control process. In the present study, three psychometric quality issues of the instrument were studied: the internal consistency (reliability), content validity and construct validity.

RESPONSE RATES

Due to the integrated nature of the study (closely linked to internship) and the informed consent procedure, a high response rate was achieved during the consecutive administrations of the IES. A summary of the response rates (RR) is presented in Table 1.

Table 1. An overview of response rates of subsequent student cohorts.

| | 2002-2003 | 2003-2004 | 2004-2005 | 2005-2006 | 2006-2007 |
|------------------------|-----------|-----------|-----------|-----------|-----------|
| Pre internship | - | - | 96% | 96% | 100% |
| Post internship | 100% | 100% | 95% | 100% | 100% |

RELIABILITY

Reliability can be defined as an estimate of the internal consistency of an instrument. Cronbach's alpha determines to what extent responses to a specific statement are in line with responses to related statements (Cronbach, 1951). This coefficient is one of the most important homogeneity statistics concerning test construction and use (Cortina, 1993). The formula of Cronbach's alpha is $\frac{N^2 \times M(COV)}{SUM(VAR/COV)}$ where N^2 is the square of the number of items in the scale, $M(COV)$ is the mean interitem covariance, and $SUM(VAR/COV)$ equals the sum of all of the elements in the variance/covariance matrix (Cortina, 1993).

It is an accepted practice to request Cronbach's alpha to be 0.7 or higher. Alpha will increase when the correlation between the different items in the IES increases.

Next to an overall internal consistency, it is of interest to study additionally the consistency of the clusters of statements that are related to particular goals or competences of pharmacists (e.g., handling medical prescriptions).

Looking at Table 2, we can conclude that the IES reflects a very high overall internal reliability (.95), and a good reliability of the different clusters in the instruments. IES is a reliable instrument that can be used to measure the students' readiness for professional life.

Table 2. Measurement of the reliability of the IES.

| | Cronbach's alpha |
|--|------------------|
| IES (in general) | .950 |
| Cluster _{organisation} | .793 |
| Cluster _{magistral preparations} | .890 |
| Cluster _{pharmaceutical care} | .775 |
| Cluster _{medicines} | .866 |
| Cluster _{medical prescriptions} | .847 |
| Cluster _{legislation/deontology} | .708 |

The reader will notice that the cluster of statements about staff management is not included in the analysis. The low numbers of statements (N=4) is insufficient to attain a high reliability.

Table 2 also shows that when looking at the different occurring clusters, there can be decided that the division in the mentioned clusters was a success and can be called reliable as can be seen that the alpha's are all respectively $> .70$. It is not surprising that the reliability of the cluster of postulates concerning magistral preparations, medicines and medical prescriptions is higher than the reliability of the cluster of postulates concerning legislation, deontology, pharmaceutical care and organisation as the latter have a broader basis than the first ones whose subjects are much more specified.

CONTENT VALIDITY

The content validity refers to the extent to which the scale items and entire scale covers all aspects of a specified subject. In the case of the IES, the instrument should reflect the competences needed to run a pharmacy in a professional way.

As mentioned above, the IES was explicitly based on the internship goals for pharmacy students on the one hand, and on the final attainment levels of the new pharmaceutical curriculum on the other hand. In view of the development of the instrument, discussions with pharmacists, supervisors of the internships, already revealed critical goals and competences with which entry-to-practice students. In addition, the discussion among the academic content specialists also helped to guarantee a close link between the IES content and the goals of internship, and the final attainment

levels. From a qualitative point of view spoken, it can be concluded that the present IES covers the necessary competences to be developed in starting professional pharmacists.

Since content validity is based on a qualitative screening of the procedure to develop a scale, also a more rigorous and quantitative approach should be adopted.

CONSTRUCT VALIDITY

Construct validity researches the relationship between a theoretical concept and a specific measuring approach. In this context, especially the structure of the IES, reflected via the eight different clusters, is at question. The analysis centres on the extent to which the clusters that a priori had been delineated, are found in the structure of the data.

To evaluate construct validity, factor analysis is applied. Factor analysis is a multivariate statistical technique to use for data-reduction, without losing important information, and is particularly helpful to understand the structure in a data set. Statements are expected to “load” on one or more factors. This factor loading is also called the communality of the variable measured with a scale item and tells something about the proportion of the variance predicted by the factor. As a rule of thumb, an observed variable is predicted to an acceptable extent when its communality is $>.45$.

To study the structure validity of the IES, an exploratory factor analysis was carried out based on a principal component analysis. Since there can be expected that the factors identified in the instrument will be correlated, a promax rotation was applied with Kaiser normalization because of the expected correlation between the factors. Hence the items can load highly on the different factors. The promax rotation reflects the linked nature of the clusters of items in the IES. Professional competences of a pharmacist are expected to influence one another.

To start a check of the conditions was carried out: a Bartlett's Test of Sphericity and a Kaiser Meyer Olkin Test of Sampling Adequacy (KMO). Looking at the results of these tests (Bartlett's Test = significant and $KMO > .6$), there can be decided that the factoriability of the data is guaranteed.

| KMO and Bartlett's Test | | |
|--|--------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | ,922 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 6408,055 |
| | df | 1176 |
| | Sig. | ,000 |

The resulting structure matrix helps to get a picture of the multidimensional structure of the way respondents have replied to the scale items. As stated earlier, the 4 statements about staff management were left out of the analysis. First there is given an explanation about the abbreviations used in the matrix.

| | |
|---------------|---|
| MAGPREP | Magistral preparation |
| MAGPREP_LABEL | Labeling of pharmaceutical products |
| SPEC | Specialities related competence |
| PC | Pharmaceutical Care |
| ORG | Organisation of a pharmacy |
| PRES | Prescription related competence |
| LAW | Law related competence |
| LAW_DEON | Deontology related competence |
| INFOADMIN | Information about pharmaceutical issues |
| INFO_PROF | Information about the profession |

Table 3. Factors identified following a Principal Component Analysis, with a promax rotation and Kaiser normalization.

| Descriptor of item | Label in original structure | Label in new structure | MAGPREP | SPEC | ORG | PRES | LAW | LAW DEON | INFO PROF | MAGPREP LABEL | INFO ADMIN |
|--|-----------------------------|------------------------|---------|-------|-------|-------|-------|----------|-----------|---------------|------------|
| | | | 30,67% | 6,81% | 5,30% | 3,52% | 3,32% | 3,02% | 2,85% | 2,53% | 2,27% |
| Control during magistral preparation | MAGPREP | MAGPREP | 0,778 | - | - | - | - | - | - | - | - |
| Choice excipient magistral preparation | MAGPREP | MAGPREP | 0,748 | - | - | - | - | - | - | - | - |
| Control after magistral preparation | MAGPREP | MAGPREP | 0,723 | - | - | - | - | - | - | - | - |
| Choice apparatus magistral preparation | MAGPREP | MAGPREP | 0,703 | - | - | - | - | - | - | - | - |
| Control incompatibilities magistral preparation | MAGPREP | MAGPREP | 0,684 | - | - | - | - | - | - | - | - |
| Methodic approach magistral preparation | MAGPREP | MAGPREP | 0,647 | - | - | - | - | - | - | - | - |
| Control dose magistral preparation | MAGPREP | MAGPREP | 0,644 | - | - | - | - | - | - | - | - |
| Protocol correct execution magistral preparation | MAGPREP | MAGPREP | 0,599 | - | - | - | - | - | - | - | - |

Table 3. Factors identified following a Principal Component Analysis, with a promax rotation and Kaiser normalization_continued

| Descriptor of item | Label in original structure | Label in new structure | MAGPREP | SPEC | ORG | PRES | LAW | LAW DEON | INFO PROF | MAGPREP LABEL | INFO ADMIN |
|---|-----------------------------|------------------------|---------|-------|-------|------|-----|----------|-----------|---------------|------------|
| Check literature about magistral preparation | MAGPREP | MAGPREP | 0.572 | - | - | - | - | - | - | - | - |
| Choice packaging magistral preparation | MAGPREP | MAGPREP | 0.570 | - | - | - | - | - | - | - | - |
| Use of the diverse medicines | SPEC | SPEC | - | 0.802 | - | - | - | - | - | - | - |
| Medical indications of the diverse medicins | SPEC | SPEC | - | 0.744 | - | - | - | - | - | - | - |
| Side effects of the diverse medicins | SPEC | SPEC | - | 0.685 | - | - | - | - | - | - | - |
| Profound knowledge of the toxicity of the diverse medicines | SPEC | SPEC | - | 0.616 | - | - | - | - | - | - | - |
| Storage of the diverse medicines | SPEC | SPEC | - | 0.578 | - | - | - | - | - | - | - |
| Medical interactions of the diverse medicines | SPEC | SPEC | - | 0.549 | - | - | - | - | - | - | - |
| Profound knowledge of OTC-medicines to anticipate self-medication | PC | SPEC | - | 0.737 | - | - | - | - | - | - | - |
| How to give advice to a patient | PC | SPEC | - | 0.768 | - | - | - | - | - | - | - |
| Pharmaceutical care | PC | SPEC | - | 0.720 | - | - | - | - | - | - | - |
| Purchasing policy | ORG | ORG | - | - | 0.853 | - | - | - | - | - | - |
| Purchasing policy of raw material | ORG | ORG | - | - | 0.819 | - | - | - | - | - | - |

Table 3. Factors identified following a Principal Component Analysis, with a promax rotation and Kaiser normalization_continued

| Descriptor of item | Label in original structure | Label in new structure | MAGPREP | SPEC | ORG | PRES | LAW | LAW DEON | INFO PROF | MAGPREP LABEL | INFO ADMIN |
|--|-----------------------------|------------------------|---------|------|-------|-------|-------|----------|-----------|---------------|------------|
| Making contact with wholesalers and salesmen | ORG | ORG | - | - | 0,724 | - | - | - | - | - | - |
| Management of the stock | ORG | ORG | - | - | 0,632 | - | - | - | - | - | - |
| The bookkeeping of a pharmacy | ORG | ORG | - | - | 0,615 | - | - | - | - | - | - |
| The economic aspects | PC | ORG | - | - | 0,722 | - | - | - | - | - | - |
| The calculation of prices of magistral preparations | MAGPREP | ORG | - | - | 0,362 | - | - | - | - | - | - |
| Controlling a medical prescription on the doses | PRES | PRES | - | - | - | 0,824 | - | - | - | - | - |
| Controlling a medical prescription on maximum doses | PRES | PRES | - | - | - | 0,814 | - | - | - | - | - |
| Controlling a medical prescription on incompatibilities | PRES | PRES | - | - | - | 0,748 | - | - | - | - | - |
| Controlling a medical prescription on instructions for use | PRES | PRES | - | - | - | 0,723 | - | - | - | - | - |
| Controlling the delivery of the prescribed medicines | PRES | PRES | - | - | - | 0,484 | - | - | - | - | - |
| Legal aspects concerning narcotic forms | LAW | LAW | - | - | - | - | 0,598 | - | - | - | - |
| Social legislation | LAW | LAW | - | - | - | - | 0,536 | - | - | - | - |

Table 3. Factors identified following a Principal Component Analysis, with a promax rotation and Kaiser normalization_continued

| Descriptor of item | Label in original structure | Label in new structure | MAGPREP | SPEC | ORG | PRES | LAW | LAW DEON | INFO PROF | MAGPREP LABEL | INFO ADMIN |
|---|-----------------------------|------------------------|---------|------|-----|------|-------|----------|-----------|---------------|------------|
| Different ways of refunding by medical insurance of medicines | LAW | LAW | - | - | - | - | 0,523 | - | - | - | - |
| Legislation concerning the diverse medicines | SPEC | LAW | - | - | - | - | 0,776 | - | - | - | - |
| Legal aspects concerning medical prescriptions | PRES | LAW | - | - | - | - | 0,771 | - | - | - | - |
| Legal regulations concerning medical prescriptions | PRES | LAW | - | - | - | - | 0,735 | - | - | - | - |
| Controlling the administrative data of medical prescriptions | PRES | LAW | - | - | - | - | 0,650 | - | - | - | - |
| Services concerning weekend and night duties | ORG | LAW | - | - | - | - | 0,641 | - | - | - | - |
| Deontological relationship with physicians | LAW | LAW_DEON | - | - | - | - | - | 0,774 | - | - | - |
| Duty of professional confidentiality and ethics | LAW | LAW_DEON | - | - | - | - | - | 0,585 | - | - | - |
| Division and arrangement in a pharmacy | ORG | INFO_PROF | - | - | - | - | - | - | 0,722 | - | - |
| Realising the necessity of dedication for the interests of the profession | PC | INFO_PROF | - | - | - | - | - | - | 0,589 | - | - |

Table 3. Factors identified following a Principal Component Analysis, with a promax rotation and Kaiser normalization_continued

| Descriptor of item | Label in original structure | Label in new structure | MAGPREP | SPEC | ORG | PRES | LAW | LAW DEON | INFO PROF | MAGPREP LABEL | INFO ADMIN |
|---|-----------------------------|------------------------|---------|------|-----|------|-----|----------|-----------|---------------|------------|
| Legislation concerning labeling of magistral preparations | MAGPREP | MAGPREP_LABEL | - | - | - | - | - | - | - | 0,873 | - |
| Labeling of magistral preparations | MAGPREP | MAGPREP_LABEL | - | - | - | - | - | - | - | 0,860 | - |
| Bandages and material for medical care | PC | INFOADMN | - | - | - | - | - | - | - | - | 0,656 |
| The use of in-service training courses | PC | INFOADMN | - | - | - | - | - | - | - | - | 0,628 |
| Identification of raw materials | INFOADMN | INFOADMN | - | - | - | - | - | - | - | - | 0,614 |
| Providing information concerning literature that can be consulted | INFOADMN | INFOADMN | - | - | - | - | - | - | - | - | 0,494 |

Table 3 summarizes the analysis results and shows how the used factor structure is being confirmed but also the even nine factors can be distinguished that account for 60.29% of the variation in student responses. As a cut-off criterion (Kaiser's criterion) an eigen value of 1 or more is chosen to retain a factor (see Table 4).

Table 4. An overview of initial eigenvalues .

| Component | Total Variance Explained | | | | | | |
|-----------|--------------------------|---------------|--------------|-------------------------------------|---------------|--------------|----------|
| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | |
| 1 | 15,027 | 30,668 | 30,668 | 15,027 | 30,668 | 30,668 | 8,921 |
| 2 | 3,336 | 6,807 | 37,475 | 3,336 | 6,807 | 37,475 | 10,030 |
| 3 | 2,600 | 5,306 | 42,781 | 2,600 | 5,306 | 42,781 | 7,591 |
| 4 | 1,724 | 3,518 | 46,299 | 1,724 | 3,518 | 46,299 | 7,973 |
| 5 | 1,625 | 3,317 | 49,616 | 1,625 | 3,317 | 49,616 | 8,788 |
| 6 | 1,480 | 3,020 | 52,636 | 1,480 | 3,020 | 52,636 | 5,234 |
| 7 | 1,399 | 2,854 | 55,490 | 1,399 | 2,854 | 55,490 | 4,284 |
| 8 | 1,239 | 2,529 | 58,019 | 1,239 | 2,529 | 58,019 | 5,671 |
| 9 | 1,111 | 2,268 | 60,287 | 1,111 | 2,268 | 60,287 | 4,405 |
| 10 | 1,109 | 2,264 | 62,550 | 1,109 | 2,264 | 62,550 | 3,497 |
| 11 | ,989 | 2,018 | 64,569 | | | | |
| 12 | ,921 | 1,879 | 66,448 | | | | |
| 13 | ,878 | 1,792 | 68,240 | | | | |
| 14 | ,794 | 1,621 | 69,860 | | | | |
| 15 | ,755 | 1,540 | 71,400 | | | | |
| 16 | ,745 | 1,521 | 72,922 | | | | |
| 17 | ,713 | 1,454 | 74,376 | | | | |
| 18 | ,690 | 1,408 | 75,784 | | | | |
| 19 | ,674 | 1,375 | 77,159 | | | | |
| 20 | ,646 | 1,319 | 78,478 | | | | |
| 21 | ,612 | 1,250 | 79,728 | | | | |
| 22 | ,593 | 1,210 | 80,938 | | | | |
| 23 | ,573 | 1,170 | 82,108 | | | | |
| 24 | ,528 | 1,078 | 83,186 | | | | |
| 25 | ,508 | 1,037 | 84,223 | | | | |
| 26 | ,499 | 1,019 | 85,242 | | | | |
| 27 | ,474 | ,967 | 86,209 | | | | |
| 28 | ,473 | ,965 | 87,173 | | | | |
| 29 | ,446 | ,910 | 88,083 | | | | |
| 30 | ,440 | ,898 | 88,981 | | | | |
| 31 | ,431 | ,880 | 89,861 | | | | |
| 32 | ,409 | ,834 | 90,695 | | | | |
| 33 | ,389 | ,793 | 91,489 | | | | |
| 34 | ,380 | ,775 | 92,264 | | | | |
| 35 | ,374 | ,762 | 93,026 | | | | |
| 36 | ,350 | ,715 | 93,741 | | | | |
| 37 | ,334 | ,682 | 94,423 | | | | |
| 38 | ,324 | ,661 | 95,084 | | | | |
| 39 | ,299 | ,609 | 95,693 | | | | |
| 40 | ,285 | ,581 | 96,274 | | | | |
| 41 | ,271 | ,552 | 96,826 | | | | |
| 42 | ,254 | ,519 | 97,345 | | | | |
| 43 | ,225 | ,458 | 97,803 | | | | |
| 44 | ,223 | ,454 | 98,258 | | | | |
| 45 | ,205 | ,419 | 98,677 | | | | |
| 46 | ,191 | ,389 | 99,066 | | | | |
| 47 | ,168 | ,342 | 99,408 | | | | |
| 48 | ,163 | ,333 | 99,741 | | | | |
| 49 | ,127 | ,259 | 100,000 | | | | |

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Cattell (1966) recommends to retain only the factors above the elbow or the break in the scree plot. Analysis of the scree plot, a plot of the eigenvalues to visualize the relative importance of the factors or components (see Figure 2), shows that the amount of factors is well considered in our study, since the line is still decreasing at the level of component 10.

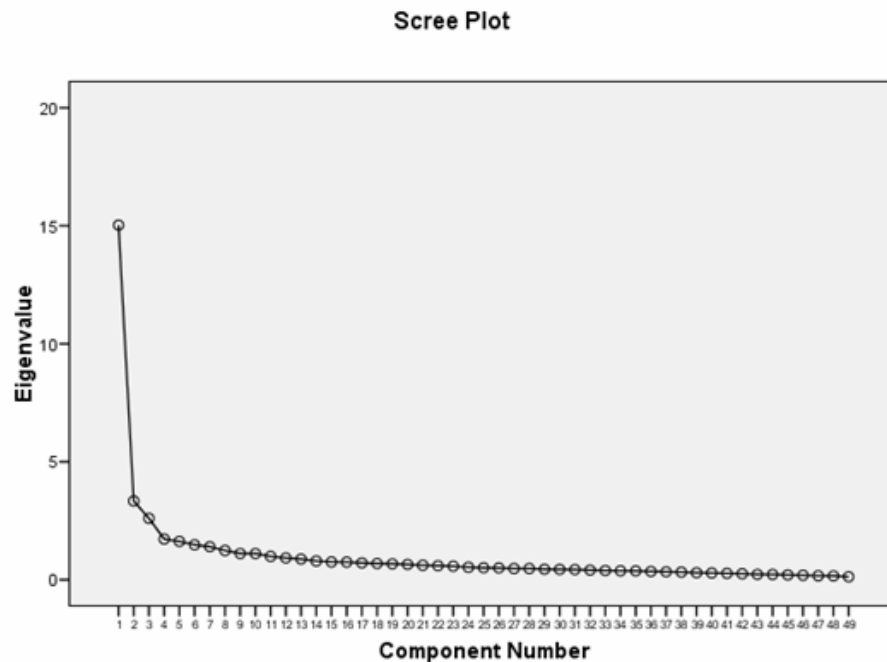


Figure 2. The scree plot of eigenvalues as a function of the component number.

The proportion of explained variance of the individual factors is mentioned at the top of Table 3. Instead of seven clusters – as defined in the IES – the factor analysis points at nine factors. Two additional factors seem to be identified. Closer analysis of these two factors indicates that these can be considered as a further refinement of original IES clusters: a new LAW-factor is identified that is labeled as LAW_DEON focusing on deontological issues. In relation to the factor about magistral preparations (MAGPREP), a new factor is identified and labeled MAGPREP_LABEL. These items focus on the labeling of magistral preparations.

A small number of items were positioned in a different factor as compared to the original item clustering in the IES (see the information in the second and third column). But a content analysis helps to understand these small adaptations. A number of items that were initially considered to belong to the factor “prescription” (PRES) reflect a rather strong emphasis on legal aspects and are therefore now positioned in the LAW factor. A small set of items related to pharmaceutical care (PC) put an emphasis on specialties or medicines related issues and are therefore now found in the

related factor (SPEC). The same applies to two items that centre on the informative dimension of pharmaceutical care (PC) and are now situated in the factor INFOADMIN.

To illustrate the correlated nature of the factor, Table 4 summarizes the correlation values between the nine factors.

Table 4. Component correlation matrix, based on the Principal Component Analysis (Promax rotation, Kaiser normalisation).

| | MAGPREP | SPEC | ORG | PRES | LAW | LAW DEON | INFO PROF | MAGPREP LABEL | INFO ADMIN |
|----------------------|---------|-------|-------|-------|-------|-------------|--------------|------------------|---------------|
| MAGPREP | 1.000 | 0.402 | 0.320 | 0.506 | 0.431 | 0.244 | 0.159 | 0.406 | 0.255 |
| SPEC | | 1.000 | 0.473 | 0.430 | 0.577 | 0.491 | 0.201 | 0.330 | 0.331 |
| ORG | | | 1.000 | 0.238 | 0.449 | 0.344 | 0.282 | 0.183 | 0.248 |
| PRES | | | | 1.000 | 0.396 | 0.200 | 0.177 | 0.336 | 0.251 |
| LAW | | | | | 1.000 | 0.337 | 0.171 | 0.248 | 0.293 |
| LAW_DEON | | | | | | 1.000 | -0.010 | 0.162 | 0.265 |
| INFO_PROF | | | | | | | 1.000 | 0.357 | 0.219 |
| MAGPREP_LABEL | | | | | | | | 1.000 | 0.174 |
| INFO_ADMIN | | | | | | | | | 1.000 |

As can be derived from Table 4, the correlation values reveal that there is an important correlation between all factors. This is an important conclusion as a pharmacist has to be able to combine all the mentioned factors during his/her daily professional life. If a pharmacist handles a medical prescription he has to look at the prescribed medicines keeping in mind the deontological issues and the patient's (medical) background. At the same time, he/she needs to control the dose of the prescribed medicines and has to provide the best pharmaceutical care as possible. Hence it is obvious that all factors in the measurement of the construct validity of the IES are somewhat correlated.

PROJECTED USE OF THE IES

As stated at the start of the article, the IES is not only helpful to continuously check the readiness of graduating students for the pharmacy profession. The instrument can also be used to analyse an evolution in student readiness over time. This is particularly interesting when during the five years of implementation of the IES, a large scale innovation of the pharmacy has been introduced and new instructional strategies have been adopted. Figure 3 shows how different cohorts report changing readiness levels in relation to the different IES clusters. Considering the

results of the first cohort that we can use for benchmarking, we can compare the results of subsequent student cohorts. The results suggest an increase in reported readiness for the profession. A detailed analysis of the longitudinal impact of the overall innovation will be presented in a separate article. Next, we can also focus on the impact of a specific innovative course (see e.g., IPK) on the IES scores.

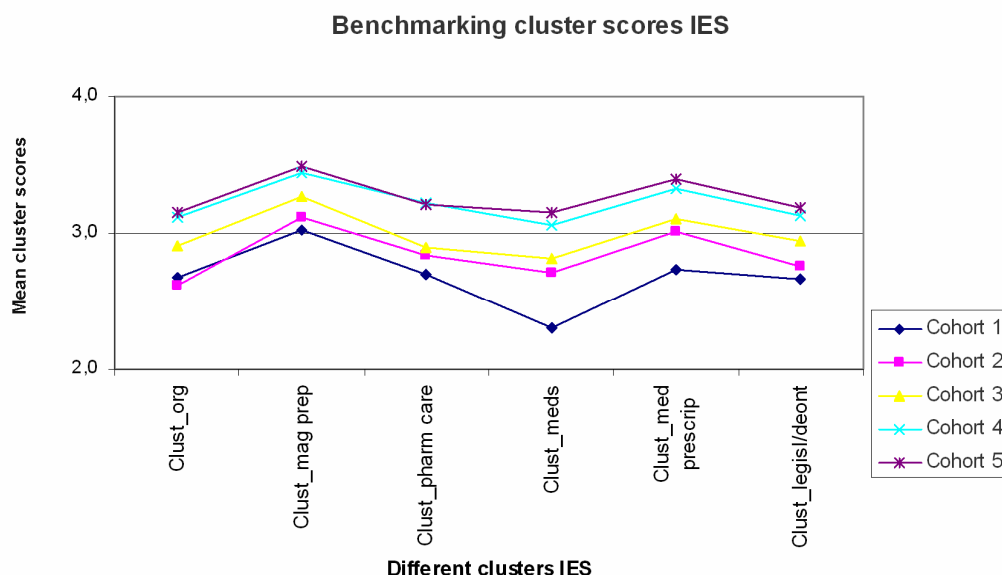


Figure 3. Bench marking of the cluster scores of the IES.

The IES can also be used to compare the readiness for the different clusters and to see in view of what specific professional competences the curriculum needs further need attention.

CONCLUSIONS

Considering a number of innovations in the pharmacy curriculum, a clear need was observed to develop an instrument to check whether graduating students are well enough prepared for professional pharmacy practice. Much attention was paid to an exhaustive analysis of the competences and goals that should be mastered/attained at the end of a pharmacy study and the 26 weeks internship. This resulted in clusters of statements about magistral preparations, administrative matters, drugs, side effects of chemicals, staff management, medical prescriptions, dosage of drugs and communication with physicians and patients. The Internship Experience Scale (IES), was developed on the basis of input from pharmacists, academic content specialists, and other practicing health care professionals. In addition, the internship manual and the final attainment goals of the innovative pharmacy sciences curriculum were used as a guideline.

On the basis of the analysis of cross-sectional data of five student cohorts, it can be concluded, that the IES is a reliable and valid instrument to investigate students' readiness for professional life in a pharmacy. The IES is therefore also useful for other schools or faculties of pharmacy that plan to assess their entry-to-practice students taken into account their respective curricula. As suggested, the IES can also be used to monitor the impact of a curriculum innovation or the evaluation of the changes in readiness caused by the introduction of new instructional strategies. In this context, the IES is a useful instrument for benchmarking purposes and analysis of reported readiness after specific innovative educational interventions.

ACKNOWLEDGEMENTS

This study was completed in conjunction with the staff of the Department of Educational Studies of the Faculty of Psychology and Educational Sciences (Ghent University) and the staff of the department of ICT Educational Technology (Ghent University).

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Chapter 3

LONGITUDINAL AND CROSS-SECTIONAL STUDY OF THE IMPACT OF A CURRICULUM INNOVATION IN A PHARMACY UNIVERSITY PROGRAMME

This chapter is based upon '*Longitudinal and Cross-sectional Study of the Impact of a Curriculum Innovation in a Pharmacy University Programme*' (*S. Timmers, M. Valcke and W.R.G. Baeyens*), as submitted to *Medical Education* in 2009.

ABSTRACT

Most evaluation studies of educational innovations focus on the short term impact, and giving educational policy makers only a limited basis to ground their decisions. The present article describes a longitudinal study of the impact of an innovation of the pharmacy curriculum at Ghent University. Next to a general impact, the study looks in particular at the implementation of a new course in the last year of the curriculum, and how this affected – in the long run - student readiness for professional pharmaceutical work. To measure the latter, the instrument “Internship Experience Scale” was used. The analysis results indicate that there is a reported increase in student readiness. The results also underpin the significant positive impact of a new course focusing on Integrated Pharmaceutical Knowledge in the final stage of the pharmacy curriculum.

Chapter 3

Longitudinal and Cross-Sectional study of the Impact of a Curriculum Innovation in a Pharmacy University Programme

INTRODUCTION

THE NEED FOR A PHARMACY CURRICULUM INNOVATION

Many pharmacy schools have adapted the content and attainment levels of their curriculum to fit the changing role of a pharmacist in today's society. A pharmacist nowadays experiences a larger involvement in patient care (Das and Das, 2001). He/she has to master specific communication competences and problem solving skills. Whereas traditional pharmacists were only held responsible for safe and effective distribution of pharmacologically active substances, today's pharmacists are expected to be in dialogue with the patients and constantly provide pharmaceutical care based on specific patient drug therapy needs. They have to identify patient-specific drug therapy problems to be resolved and/or prevented and have to develop a patient-specific care plan in cooperation with the patients and the other care providers to attain the best cost-effective situation for both patient and health care system (Tromp, 1999). Pharmacists are therefore required to possess not only the basic knowledge but also the required skills to meet these new demands. As patients nowadays are much more emancipated, they want their pharmacist to possess full knowledge of areas related to medicine, chemistry, diseases and physiology, botany, toxicology and many more academic and practical competences.

It is of importance that universities nowadays respond to these needs for a professional pharmacist that has to be able to apply a large body of integrated pharmaceutical knowledge. This is, for instance, reflected in a more practice oriented approach to learning and instructional designs. For example, European Faculties of Pharmacy are expected their curricula to reflect the guidelines

set out by the European Association of Pharmaceutical Faculties (EAPF) concerning pharmaceutical care (Leemans and Laekeman, 2000; Tromp, 1999). Entry-to-practice students are expected to be able to analyse clinical situations in a rational and logical way and able to use and integrate the acquired core knowledge to solve pharmaceutical problems. Faculties of pharmacy nowadays provide students the possibility to develop these skills in more practice-based courses (Alsharif et al., 1999).

In spite of the efforts made by various faculties of pharmacy to adjust their curriculum, the evaluation of the impact of these innovations has only been investigated during short term studies (Latif and Berger, 1999; Reddy Indra, 2000; Reeves and Francis, 2001; Cisneros et al., 2002; Marriott, 2007; Black and Plowright, 2008; Hyvärinen et al., 2008). An additional limitation of these studies is that they build their evaluation on feedback forms that ask for ideas for future improvement (Hong et al., 1998; Monaghan et al., 2000; Bouldin and Wilkin, 2000; Sibbald, 2003; Hind et al., 2003; Curran et al., 2008). Studies that analyse the impact over a longer period of time in pharmacy education are rare, if available at all.

It is obvious that longitudinal studies about the impact of a curriculum innovation present an added value. First, they help to develop an understanding of the impact of an innovation beyond the initial impact that is often due to a novelty effect. Next, they help policy makers to be more confident about investments made in new courses, technology implementations, etc. Lastly, long term studies also help to ground evidence-based instructional approaches in the field of pharmacy and medical education (Van der Veken et al., 2008).

The latter inspired the Pharmacy Faculty of Ghent University to set up a longitudinal study related to the implementation of a particular curriculum innovation aimed at fostering student readiness for the pharmacy profession.

Before analysing the results of the study in a first part, the context of the curriculum innovation is pointed out.


CURRICULUM INNOVATION AT THE FACULTY OF PHARMACEUTICAL SCIENCES OF GHEENT UNIVERSITY

Due to the changed professional status of a pharmacist in the current health care system, universities have adapted their educational system during the last decade. At Ghent University, the traditional programme was transformed into a Bachelor-Master programme (Bologna Declaration,

June 1999). The Bachelor programme or undergraduate programme takes three years of study. Bachelor students can continue with either a two year Master in *Pharmaceutical Care* or a two year Master in *Drug Development* (Final Attainment Levels, 2002). The competences of master students are expected to reflect the expertise of a professional pharmacist. The latter implies that students in both Master programmes have to carry out a 26 weeks lasting pharmacy internship, commonly in the context of a community pharmacy. They can also opt for a partial internship in a hospital pharmacy (The Council of European Communities, 1985).

In general, the new curriculum required the adoption of new instructional approaches, such as problem-based learning (PBL) and other types of active learning. This process of successive changes started in the academic year 2003-2004. However, the most substantial change in the curriculum was the implementation of a completely new course in the fifth and last year of the pharmacy curriculum. The course is called Integrated Pharmaceutical Knowledge (IPK) and was officially part of the programming from the academic year 2004-2005. This new course is set up in parallel to the internship during the last year of the pharmaceutical programme (Study Guide Academic Year 2004-2005). The IPK course is supported with a computer-supported collaborative learning environment. Students – wherever they take their internship – are required to work regularly on patient cases that are presented in these on-line discussions. In this way, students have to solve the cases by integrating their acquired pharmaceutical knowledge when they analyse different patient cases, clinical situations and solve related pharmaceutical problems.

Students start with the IPK course in November, and end in June of the next year when they take a final exam for this course. Students work in groups of 6 to 7 students. As explained above, they work together on the basis of patient cases and several related pharmaceutical problems. They are expected to develop solutions/answers by integrating their knowledge and/or via consulting the research literature. In view of the latter all students have on-line access to journals, the Web of Science, etc. During the first five weeks of the course, students work during face-to-face discussions with their peers in the mentioned small groups to reach a shared conclusion/solution for the given problems. After this introductory period, all students leave for their internship, which lasts three months. Due to their physical distribution all over the country, they continue their collaborative work, but now via asynchronous discussion groups.

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| GENEESMIDDELENVOORSCHRIFT | | |

In this case a *woman* (20 years), Body Mass Index = 27, who suffers from hirsutism, comes into the community pharmacy with the present prescription. She does not take other medicines. She does not smoke or abuses alcohol. She does not know her bloodtype. She informs the pharmacist that this is the first time that she will use this medicine.

Questions:

- What will be the advice to be given to this patient concerning the posology?
- What will be the advice to be given to the patient in case of vomiting or diarrhoea?
- What do you think about the choice of contraceptive for this patient?

Figure 1. Example of a minor part of a patient case presented to the students in the computer-supported collaborative learning environment.

The computer-supported collaborative learning environment (CSCL) makes it possible that they can work in a flexible way, independent of time and place. Working by means of the electronic learning environment also offers another benefit. Although the students are located at diverse places, it is still possible to communicate with them in an efficient way and provide them with critical feedback. At the finish of the internship, the IPK course ends by taking an exam that is based on 50 multiple choice questions. These questions are partially built on patient cases and related problems that have been discussed in the CSCL setting. In summary, the new Integrated Pharmaceutical Knowledge course combines a series of innovative instructional approaches: problem-based learning, task-based learning, case-based learning, active learning and e-learning.

To investigate whether the IPK course had an additional beneficial impact on student readiness for the pharmacy profession, next to the expected impact of the new Bachelor-Master curriculum, it was decided to set up a longitudinal cross-sectional evaluation study.

RESEARCH DESIGN

THE INTERNSHIP EXPERIENCE SCALE

To determine the readiness of last year's students for entry-to-practice, a new instrument has been developed: the Internship Experience Scale (IES), (see Timmers et al. (2009) for an extensive description). This 53-item instrument reflects the goals of pharmacy internship (Remon and Van Tongelen, 2004) and the critical learning outcomes of the pharmacy curriculum in view of working in a community or hospital pharmacy (Final Attainment Levels after introducing Bachelor-Master structure, Faculty of Pharmaceutical Sciences, Ghent University, 2002).

Each item in the IES represents a statement about the tasks of today's pharmacist. Several clusters of items can be distinguished: (1) staff issues; (2) the organisation of a community or hospital pharmacy; (3) magistral preparations; (4) pharmaceutical care; (5) medicines; (6) medical prescriptions; and (7) legislation and deontology. Statements of the different clusters are presented randomly to avoid interference when reacting to items of the same cluster (Timmers et al., 2009). Respondents are asked to rate on a five-point Likert scale to what extent they have attained the professional goal or were able to carry out the task described in the statement. The five-point scale ranges from "amply sufficient" to "completely sufficient". Students could also indicate that an IES item was not relevant considering the nature of their internship.

The IES is administered twice to last year's pharmacy students. They are asked to fill out the instrument at the start and again at the end of their final academic year when returning from their internship.

RESEARCH SUBJECTS

As explained above, students involved in the study are enrolled for their final year when studying Pharmaceutical Sciences. This implies they already passed four years of studies and hence can be considered to master the scientific knowledge base and skills to be prepared for professional life. These students are expected to be successful during the six months internship in a pharmacy. A "typical" last year pharmacy student is female, and aged between 22 and 33 years.

RESEARCH PROCEDURE

In view of the longitudinal evaluation of the curriculum innovation, all last year's students were invited to take part in the study and the completion of the IES. Informed consent was obtained from all students. Approval for the study was given by an Ethical Committee. The study was fully integrated in the instructional process. This resulted in very high participation rates of students (> 95.9%).

Students were assigned a 20 minutes time limit for filling out the IES. The first two cohorts of students filled out a paper-and-pencil version of the instrument (2002-2003 and 2003-2004). The subsequent student cohorts replied to an electronic version of the instrument after logging on to the electronic learning environment. On-line responses were saved on a secure server of the university. On-line administration also helped to counter a bias caused by the presence of the main researcher of the study (Trochim, 2006). Students could fill out the IES when and where they wanted, but within a specific time frame.

After administration of the IES, a quality control cycle started to check whether all students had completed the document. After the second administration of the IES at the end of the year, student names and student numbers were removed from the file to guarantee anonymity and confidentiality.

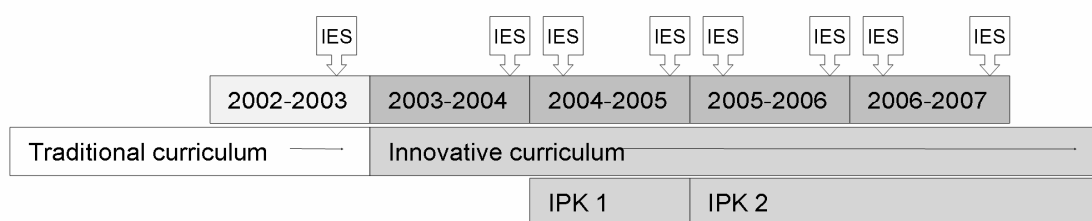


Figure 2. Overview of the research procedure to study the longitudinal impact of the curriculum innovation in general and the impact of the Integrated Pharmaceutical Knowledge course in particular.

Figure 2 gives a graphical representation of the longitudinal set-up of the study. The IES has been administered in a systematic way since the implementation of the new pharmacy curriculum and since the introduction of the new “Integrated Pharmaceutical Knowledge” course. The

instrument was also administered in April 2003 to last year students who were never involved in the new curriculum and had no experience with the new IPK course (cohort 2002-2003). The latter cohort can be considered as a reference or control group to study the impact of the new curriculum on their readiness for professional life. In the longitudinal study, the IES scores of this reference group are compared to the IES administration of students graduating in the following academic years: 2003-2004, 2004-2005, 2005-2006 and 2006-2007. The longitudinal nature of the study allows to counter the potential impact of an interaction between testing and treatment, or to counter for the motivating effect of the innovation (Hawthorne effect) as suggested by Trochim (2006).

Figure 2 also indicates the timing of the introduction of the new on-line course “Integrated Pharmaceutical Knowledge”. It was first introduced during the academic year 2004-2005. A revised version was implemented during the subsequent academic years. It also became an official subject in the pharmacy curriculum.

RESEARCH QUESTIONS AND HYPOTHESES

In health care professions, patients rely upon the professional staff for safe, effective and efficient service and care provision. It is therefore not surprising that questions are raised about the impact of an academic educational programme and whether it prepares students for professional life. This is, for instance, reflected in complaints of internship tutors about the readiness of last year students.

The first research question centres on the overall impact of the new Bachelor-Master curriculum on student readiness for the profession. The new curriculum builds on the revised “Final Attainment levels of the curriculum of Pharmaceutical Sciences” that have been adopted in the academic year 2003-2004. As explained above, the innovation implied the study of new curriculum content and the adoption of new instructional techniques such as a case-based learning. We expect that students graduating from that moment on will report an increased readiness for the profession on the basis of the IES administration. We can expect a gradual change, since the implementation of an innovation takes time before new contents and instructional strategies are fully developed and implemented. A comparison of the IES scores over time helps to point out when a significant increase in reported readiness can be observed and also helps to determine in relation to what specific clusters we can observe a significant increase. At the same time, this can also help to detect specific

competences that are underdeveloped and/or need additional attention during an earlier phase in the curriculum.

The second research question focuses on the added-value of the implementation of the new course “Integrated Pharmaceutical Knowledge”. Does the involvement in the on-line discussions in a computer-supported collaborative learning environment offer an added value to the education of pharmaceutical science students? Put otherwise: is there a positive impact on the development and attainment of professional pharmacy competences when working on patient cases by means of on-line discussions during the internship in the last year of the curriculum of pharmaceutical sciences? In addition, since the IPK course is implemented on top of an overall curriculum innovation, we also have to analyse the specific added value of the IPK experience. It is possible that the added value will be lower when we study the results of students in cohorts that experienced to a stronger and larger extent the implementation of the new curriculum. The latter cohorts of students have studied new pharmaceutical contents and have been involved in case-based learning, task-based learning, and other active learning approaches next to the on-line collaborative learning activities in the IPK course.

STATISTICAL ANALYSIS

Prior to the statistical analysis, the research data were screened for accuracy, missing values and outliers. Because of the high response rates in the study, a number of student records were removed without the risk of sample bias; for instance in the case when a pre-test or post-test administration of the IES was missing.

To study the longitudinal impact of the innovative curriculum, analysis of variance was carried out with the students’ cohorts as factors. Considering the pre-test IES results, an extension of this analysis can help to determine if the differential impact of the implementation of the “Integrated Pharmaceutical Knowledge” course has a beneficial effect.

All data were analysed by means of the Statistical Package for the Social Sciences (SPSS) 15.0 for Windows.

RESULTS AND DISCUSSION

DATA SCREENING

As mentioned above, the response rate (RR) was very high: Cohort 1 (2002-2003) attained a RR of 1.00, cohort 2 (2003-2004) 1.00, cohort 3 (2004-2005) 0.96 for the pre-test and 0.95 for the post-test, cohort 4 (2005-2006) 0.96 for the pre-test and 1.00 for the post-test and finally cohort 5 (2006-2007) attained a RR of 1.00 for both the pre-test and post-test.

Subjects with incomplete record (no pre-test or post-test IES scores) were excluded from the analysis. Considering the very high RR, we can conclude that the results will remain representative for the student population.

Analysis of specific IES cluster scores, revealed that the cluster about staff management was hardly usable. More than 11% of the students indicated that these items were not relevant considering the nature of their internship. The latter can be expected considering their position as an intern in a pharmacy context. In addition, it is to be mentioned that no course in the curriculum pays explicitly attention to these issues. The “staff” cluster is therefore not incorporated in the further analysis procedure.

LONGITUDINAL IMPACT OF THE EDUCATIONAL INNOVATION

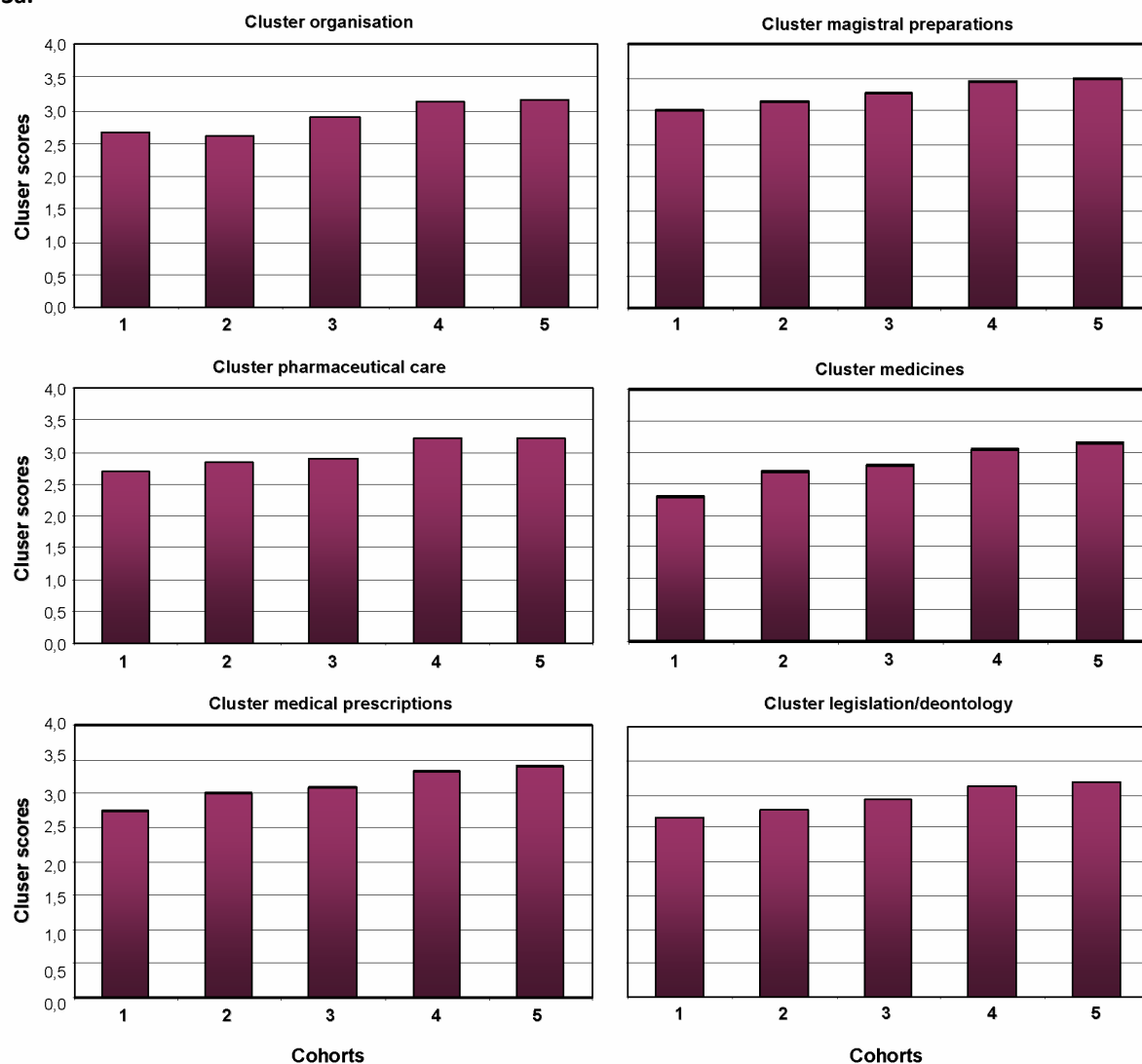
Table 1 summarizes the descriptive results of the statistical analysis. Mean cluster scores and the analysis of variance results are presented for the different IES clusters. N refers to the number of students in the different cohorts or the successive academic years.

Table 1. Mean IES cluster posttest scores ; ANOVA (* $p < .05$).

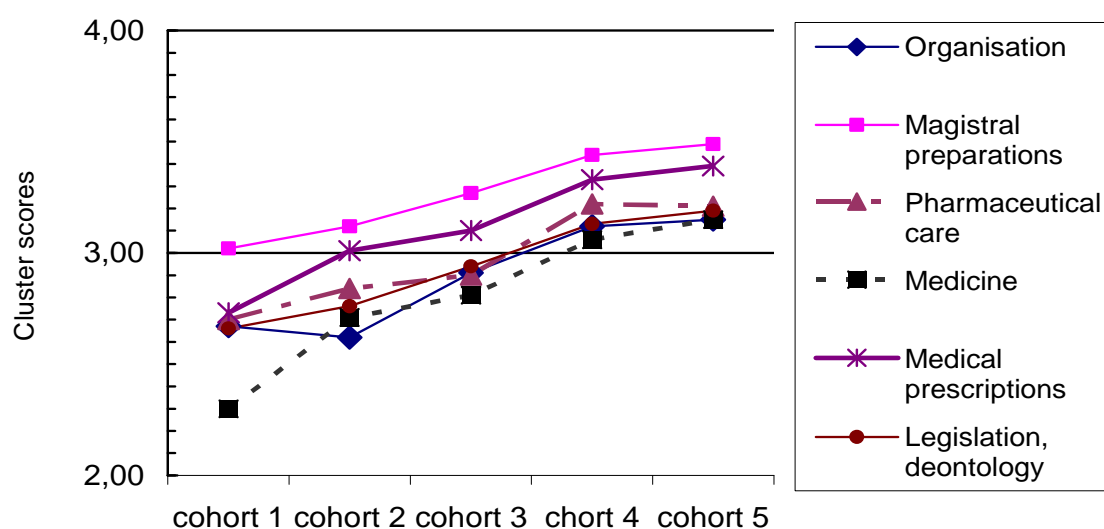
| | Mean IES cluster Scores | | | | | Test of differences over time in cluster scores |
|--|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
| | Cohort 1 <i>N</i> = 50 | Cohort 2 <i>N</i> = 50 | Cohort 3 <i>N</i> = 73 | Cohort 4 <i>N</i> = 73 | Cohort 5 <i>N</i> = 67 | ANOVA <i>F</i> (<i>p</i> -value) |
| IES | | | | | | |
| Cluster _{organisation} | 2.67 | 2.62 | 2.91 | 3.12 | 3.15 | 3,184 (.014)* |
| Cluster _{magistral preparations} | 3.02 | 3.12 | 3.27 | 3.44 | 3.49 | 3,198 (.014)* |
| Cluster _{pharmaceutical care} | 2.70 | 2.84 | 2.90 | 3.22 | 3.21 | 3,066 (.017)* |
| Cluster _{medicines} | 2.30 | 2.71 | 2.81 | 3.06 | 3.15 | 3,194 (.014)* |
| Cluster _{medical prescriptions} | 2.73 | 3.01 | 3.10 | 3.33 | 3.39 | 3,174 (.014)* |
| Cluster _{legislation/deontology} | 2.66 | 2.76 | 2.94 | 3.13 | 3.19 | 3,196 (.014)* |

The mean IES cluster scores clearly reflect an increase of readiness for the profession over time. This is clearly depicted in Figures 3a + 3b. The results suggest that over the years, students report that they are better prepared for professional life in the pharmacy context. The impact of the implementation of the new curriculum is particularly clear in the cohort 2. But also during the consecutive years, an increase can be observed in reported readiness. From cohort 5 on, there is hardly a further progress in reported readiness. As today's role of a pharmacist is multidisciplinary, as reflected in the new pharmacy curriculum goals, we also expect that the improvement in IES scores is observed in each individual IES cluster. Figures 3a and 3b suggest that we can be confident about the generic impact of the curriculum innovation. In addition, we also observe very high reported readiness levels in relation to all IES clusters at the end of academic year 2006-2007.

3a.



3b.



Figures 3a + 3b. Representation of the evolution over time in mean IES cluster scores.

The ANOVA results point at significant differences in cluster scores over time. A post hoc analysis helps to clarify exactly which cohorts differ in a significant way. Since the Levene's Test of Equality of Error Variances was not significant, we can state that the variances are homogeneous.

The post hoc (LSD and Gabriel) results are consistent. They point out that the biggest changes are to be found in the academic years 2004-2005 and 2005-2006, the years where the IPK course respectively was officially built in and thoroughly reformed.

THE DIFFERENTIAL IMPACT OF THE NEW “INTEGRATED PHARMACEUTICAL KNOWLEDGE COURSE”

Since from 2004-2005, the innovative curriculum was enriched with the new course about “Integrated Pharmaceutical Knowledge”, the second research question focuses on the additional and differential impact of this course. A basic comparison of the mean pre-test and post-test IES scores of the students in the three cohorts results in the following paired-sample t-test analysis results.

Table 2. Paired Sample t-test to analyse differential impact of IPK (* $p < .05$, ** $p < .01$ *** $p < .001$) .

| | Impact of IPK | | |
|---|---------------------------|-----------|-----------|
| | Paired t-test and p-value | | |
| | 2004-2005 | 2005-2006 | 2006-2007 |
| IES | Cohort 3 | Cohort 4 | Cohort 5 |
| | N=70 | N= 70 | N=67 |
| Cluster _{organisation} | .448 *** | .388 * | .054 |
| Cluster _{magistral preparations} | .495 *** | .320 ** | .068 |
| Cluster _{pharmaceutical care} | .281 * | .254 | .181 |
| Cluster _{medicines} | .351 * | .194 | .125 |
| Cluster _{medical prescriptions} | .282 * | .218 | .181 |
| Cluster _{legislation/deontology} | .315 ** | .309 ** | .272 * |

The expectations about the potential impact of the IPK course are partially confirmed. In cohort 3 (2004-2005), we clearly observe a significant overall increase in IES scores that might be attributed to the IPK course experience ($p < .05$). These differences are also present in students of cohort 4, but are no longer significant for IES cluster Medicines and Medical prescriptions. In cohort 5, the differences in only different in IES cluster about Legislation and deontology.

The partial impact of the IPK course is in line with the results of comparable implementations of computer-supported collaborative learning in a curriculum on learning performance and cognitive processing (see Schellens and Valcke, 2005 for an overview).

But the results also suggest, next to the initial added value of the IPK course, a decreasing added value during the subsequent implementation years. This can reflect the significant growing impact of the overall curriculum innovation that was analysed earlier. The analysis results also match our expectation that this added value might decrease considering the growing impact of the overall innovative curriculum in student experiences. Students of cohort 4 and 5 have been influenced by more adapted courses and new educational techniques. This can explain the higher pre-test IES cluster scores. This suggests that we observe here an interaction effect of different treatments (Trochim, 2006).

To analyse the added value of the IPK on top of the overall curriculum innovation, we carried out an additional analysis of variance with the cohorts as factors and the pretest IES scores as covariates to take into account the initial differences between students. These initial differences can be hypothesized to be the effect of the innovative curriculum as it was experienced during the earlier years. Looking at the results of this ANCOVA we can state, that only the cluster scores concerning the magistral preparations were influenced by the parallel scores in the pre-test. This is an important result, as can be stated that the IPK course has an added value for all the different clusters except for the cluster concerning magistral preparations, this could be expected because students have been taught both in the third and in the first months of the fifth year a course concerning magistral preparations.

IMPLICATIONS, LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The research findings underpin the basic assumptions that directed the curriculum innovation. The current implementation of the new curriculum can be considered as a valid “translation” of the Bachelor-Master orientation in the curriculum, the newly developed courses (such as the IPK course), and the adoption of next instructional interventions such as on-line learning, collaborative learning, case-based learning, and so forth.

Despite the promising findings, a number of limitations have to be mentioned. For instance, the way “readiness for the profession” was measured, can be criticized. The IES builds on self-

reported measures. Nevertheless, written and computer-based tests, known as direct assessment systems, have been advocated as more meaningful indicators of practioners' competences than indirect assessments of competence, such as records of attendance at educational events (Austin et al.,2004). A second limitation is the fact that the IES was the only dependent variable in the study. Future studies could also build on exam scores, actual observation and analysis of internship behaviour, and data obtained via interviews or focus groups. A last limitation is the "generic" analysis of the innovative curriculum implementation. Future studies could – as was exemplified by the IPK course study, explicitly focus on other specific innovative interventions. Moreover, this study could be based on a longitudinal study of a specific cohort of students; thus countering the limitations of a cross-sectional study.

CONCLUSION

In this article, the Internship Experience Scale (IES) was used to carry out a longitudinal cross-sectional evaluation of a curriculum innovation and the added value of a new "Integrated Pharmaceutical Knowledge" (IPK) course that was set up in parallel to the internship during the final phase of the curriculum. The results are positive and point at a significant increase in reported readiness for the pharmacy profession by students during the consecutive implementation phases of the curriculum. It is remarkable that the positive impact is observed in relation to all the different clusters that define the critical competences of a beginning pharmacist. The results also confirm the added value of the IPK course, but also a decrease in impact due to an interaction effect with the overall curriculum innovation. The latter is an important finding since most evaluation studies about educational evaluation do not recognize the potential interaction effect with other changes in the curriculum context. The results are also of importance for educational policy makers since the findings present an evidence basis to the direct future strategic development of the pharmacy curriculum.

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Chapter 4

THE IMPACT OF COMPUTER- SUPPORTED COLLABORATIVE LEARNING ON INTERNSHIP OUTCOMES OF PHARMACY STUDENTS

This chapter is based upon '*CSCLE and Internships of Pharmacy Students - The Impact of Computer-supported Collaborative Learning on Internship Outcomes of Pharmacy Students.*' *International Journal of Interactive Learning Environments*, 16(2), 131-141 (2008), (S. Timmers, M. Valcke, K. De Mil & W.R.G. Baeyens)

ABSTRACT

The present article focuses on an evaluation of the impact of an innovative instructional design of internships in view of a new integrated pharmaceutical curriculum. A key innovative element was the implementation of a computer-supported collaborative learning environment. Students were – as part of their formal curriculum – expected to work in a systematic and collaborative way in discussing and solving real life cases. Students in the role condition were assigned specific roles. The cases were an additional critical variable in the study. The results of the study demonstrate that both independent variables – role assignment and cases – have a significant impact on levels of knowledge construction and especially on the attainment of objectives of the new integrated pharmaceutical curriculum.

Chapter 4

Impact of Computer-Supported Learning on Internship Outcomes of Pharmacy Students

INTRODUCTION

“Pharmacy practice demands that pharmacists draw upon competences and outcomes that enable them to perform the functions that support the delivery of pharmaceutical care” (Alsharif et al., 1999).

The former observation has heavily influenced the design and development of curricula and accreditation standards. At the same time, a large variety of innovations in the instructional design of pharmaceutical education has been researched and implemented. The present study was set up to research an innovative approach to guarantee the evidence-based use of integrated pharmaceutical knowledge by internship students.

INTEGRATED PHARMACEUTICAL KNOWLEDGE AND CURRICULUM REFORM

Curriculum design in view of developing optimal competences in pharmaceutical care implies that students integrate the conditional knowledge and skills in view of coping with clinical situations in a rational and logical way. This implies they have to apply their prior knowledge base, in view of analysing and interpreting data of patient cases. In the context of the curriculum of Ghent University, an important curriculum reform was introduced in 2002 to stress the importance of this central objective.

In line with international trends, an evidence-based approach and a competency-based orientation of the curriculum have been adopted. The new integrated curriculum consist of four sets of competences to be attained by students at the end of their study: (1) general societal competences that stress the importance of communication skills, critical skills, ethical issues, health policy and management issues, deontological issues, legal issues, and finally competences related to innovations in the profession; (2) research related competences that reflect applied scientific research skills and the execution of laboratory procedures; and (3) pharmaceutical discipline related knowledge that comprises (a) chemistry, therapeutic, pharmacological, toxicological and biomedical knowledge, (b) objectives focusing on patient care and sound use of drugs and (c) the production of drugs and quality control.

The implementation of the new curriculum has especially affected the instructional design of the internship of 26 weeks in the fifth year of the pharmacy educational program. The present article focuses on the impact of this redesign on educational outcomes.

REDESIGN OF THE INTERSHIP LEARNING ENVIRONMENT: CASES AND COLLABORATIVE LEARNING

The instructional redesign has directed in two ways the way internships are now being set up. Firstly, instead of an independent internship, students are now also formally expected to be involved in a structured computer-supported collaborative learning environment (CSCLE) during their internship. Secondly, in the CSCLE they have to discuss and solve five real life cases.

The case-based approach offers rich opportunities to present interns with real life problems. The cases have been developed in a systematic way to guarantee that they cover the full complexity of the new curriculum: an impetigo case, a case related to Clamoxyl[®] prescription in relation to tooth extraction, a rheumatism case, a severe persisting headache case and a hypertension case. Next to a description of the patient, the questions of the patient and information about the prescription by a GP, the students were presented with some guiding questions that question the nature of the prescription, the relevance of the medication, symptoms, argumentation to choose alternatives, etc. Each case was dealt with during two weeks. To guarantee the real life nature of the cases, a researcher intervened in a standardized way after 1 week and introduced new information about the case. For instance, in the Impetigo case, the patient left the country to travel to India and fell ill. Internship students were expected to consider the additional complications of this development in the case.

Each case was analysed by a team of specialists to indicate the objectives that could be pursued by this specific cases. This guaranteed the validity of the cases in view of the pharmaceutical curriculum and guided the assessment and evaluation of student input when discussing and solving the case.

The CSCLE implied that students had to collaborate on-line with other internship students to discuss and solve the pharmaceutical cases. It is hypothesized that the on-line collaboration fosters knowledge acquisition and competency development due to the explicitation of knowledge and skills and the exchange and sharing of information (De Wever et al., 2008). Working in a CSCLE can be considered as a particular form of cooperative learning that – considering the extensive available empirical base – has proven to be beneficial on a large number of outcome parameters (Johnson and Johnson, 1994; Slavin, 1995). The approach can be compared to problem-based learning approaches where the key ingredients are: social and personal learning processes, learners' shared experiences, responsibility, monitoring, and self-regulated learning (Stromso et al., 2004). This is in line with social constructivist assumptions about knowledge acquisition (Duffy and Jonassen, 1992; Schellens and Valcke, 2006; Salomon and Perkins, 1998; Stahl, 2005). Empirical evidence is available in the literature to support these assumptions (see for an overview Schellens, Van Keer & Valcke, 2005). De Wever et al. (2008) summarize five advantages of applying the computer-supported collaborative learning approach: (1) students get opportunities to practice with information and communication technologies in the context of their professional training (Hagdrup et al., 1999); (2) they are forced to keep up with the rapid growth in /pharmaceutical knowledge; (3) the asynchronous nature of the on-line discussion groups makes the learning environment independent of time and location and suitable to cope with the distributed characteristic of internships (Bernard and Lundgren-Cayrol, 2001); (4) asynchronous discussions provide students with time to reflect, think, and search for additional information before contributing to the discussion (Pena-Shaff and Nicholls, 2004) and (5) asynchronous discussion groups can be used to integrate clinical placements within the instructional design (Hagdrup et al, 1999).

Despite the available empirical evidence about the impact of CSCLE, some authors also point at non-conclusive results of a number of studies (Archer et al., 2001). Empirical studies about the impact of CSCLE have lead to the definition of design principles that are especially related to structuring the contributions of students. Especially the assignment of roles is considered of importance to activate, stimulate and orientate the students (Strijbos et al., 2004). In the present study, four roles were presented to students: (1) the moderator who launches the discussion and

fosters the continuous active participation of other students in the group, (2) the question-asker who posts continuously critical questions and/or links questions to clarify contributions of other students, (3) the summarizer who is expected to submit summaries that integrate the outcomes of the discussions and the conclusions thus far and (4) the source researcher who backs up findings, statements, conclusions with references from the literature, research evidence, and other publications.

RESEARCH DESIGN

PARTICIPANTS

A quasi-experimental design was set up to study the impact of the CSCLE. The entire population of fifth year's students in the pharmaceutical programme was involved in the study (N=77). The population consisted of 60 female and 17 male subjects. Students were assigned at random to a group of 7 to 8 students. Participation in the study was obligatory since the internship was a formal part of the study programme.

PROCEDURE

Each of the ten groups studied and solved during two weeks a case. After two weeks a new case was presented. The first case was considered as a warming up case to get acquainted with the technology and the learning format. Data from this case were excluded from the analysis. To study the differential impact of role assignment, five groups were presented with roles and five groups did not receive role assignments. The roles were assigned by the researchers to randomly chosen students within the role condition. Students were expected to post at least 4 messages per case. The research was approved by an ethics review committee. Informed consent was obtained from all participating students.

RESEARCH VARIABLES

Two independent variables are distinguished in this study. The first variable builds on the roles. The impact of the different roles will be studied, next to a comparison of the impact on the dependent variables when discussing with or without roles. A second independent variable is related to the nature of the four cases. Since the cases differ in the extent they help to pursue subsets of specific curriculum objectives, this characteristic is considered as important to study the impact of

CSCLE. Some authors point at the critical nature of the discussion themes or cases. Task complexity has e.g., been detected to influence in a significant way a number of dependent variables (Schellens, et al., 2005).

Two dependent variables are considered in this study. A first variable measures the extent to which student contributions to the discussions mirror the mastery of the learning objectives in relation to each case. Based on the prior analysis by a group of specialists, student contributions at theme level were evaluated by two independent researchers. This resulted in an Integrated Curriculum Score (ICS) for each student and each discussion. In view of further analyses, these ICS scores were standardized. In the CSCLE literature, little research is available that studied thus far the impact on actual knowledge and skill acquisition. Most studies focus on indirect outcome measures (knowledge construction, types of contributions, number of contributions, etc.).

A second dependent variable focused on the level of knowledge processing. The analysis model of Veerman & Veldhuis-Diermanse (2001) was adopted that distinguishes between 4 levels of task-oriented communication. It is hypothesized that students in the CSCLE will attain higher levels of knowledge construction. Three consecutive levels of knowledge construction are distinguished, representing higher levels of knowledge construction:

1. Presentation of new information. Learners present information that is new in the context of the discussion. Further distinction is made between the presentation of three types of information:

- (a) facts, for example, “On the internet you can find some examples of exercises and you get the solution if you click on the following link...”,

- (b) experiences or opinions, for example, “I personally would choose to explain to the other students why we accepted these students with emotional disabilities...”,

- (c) theoretical ideas, for example, “I found a definition of constructivism, constructivism means active learning ...”.

2. Explication. This is a type of communication that reflects a further refining and/or elaboration of earlier ideas, for example, “I know that A. already mentioned that adding some links to the learning environment would make it a more constructivist one. I would like to go further into this by giving a few examples of the kind of links that I think could be useful...”.

3. Evaluation. This type of written messages corresponds to a critical discussion of earlier information or ideas. Evaluation goes beyond a simple confirmation or negation and reflects argumentations, reasoning, justifications, for example “I can not fully agree on this one. I

know B. argued that because of these specific features one can assume that this is a constructivist learning environment. But I would like to refer to what we discussed in the working sessions, we then agreed that there had to be more than 2 or 3 features...”.

ANALYSIS PROCEDURE

The transcripts of the discussion input of all 77 students in the four discussions were taken as the basis for analysis. Since the first case was considered as a try-out, the data of this case were excluded from the analysis. Each complete message of a student was considered as a unit of analysis for the coding. In the present study this resulted in a data set of 1559 analysis units. Only 6% of these messages were non-task related (technical, social, planning or nonsensical). The resulting 1466 analysis units were coded on the basis of the analysis model of Veerman & Veldhuis-Diermanse (2001) at the level of each discussion and for each individual student. In view of calculating the impact on ICS, two groups in the role condition and two groups in the non-role condition were randomly selected. The transcript of these discussions were analysed in view of calculating an Integrated Curriculum Score (ICS).

The reliability of the coding and scoring approach was controlled for by calculating percentage agreement between the two independent researchers. Inter-rater agreement was on average 94.92%, indicating that a high reliability of the research data was obtained.

HYPOTHESES

Building on the theoretical basis, three hypotheses were put forward:

- Hypothesis 1: The nature of the discussion case has a differential impact on the dependent variables: ICS and levels of knowledge construction.
- Hypothesis 2: Role assignment has a beneficial impact on the dependent variables. Groups that are asked to follow role assignments will attain significantly higher Integrated Curriculum Scores (ICS) and/or an average higher level of knowledge construction.
- Hypothesis 3: The nature of the role assigned to students will result in significant differences in ICS and/or the average level of knowledge construction.

Hypotheses are tested by applying analysis of variance (ANOVA). When the Levene's statistic to test the homogeneity of variance is significant, Tamhane's F values will be reported instead of Sheffe's F statistics. $p < .01$ is put forward as the critical significance level.

RESULTS

GENERAL RESULTS

Table 1 gives an overview of the average level of knowledge construction (LKC) obtained in the context of this case and the average ICS score obtained in relation to the cases. Between brackets we report the number of messages analysed.

Tabel 1. Descriptives reflecting the relationship between the four cases and the dependent variables.

| | All cases | Impetigo | Tooth extraction | Rheumatism | Severe headache |
|------------------------------------|----------------|---------------|------------------|----------------|-----------------|
| Average LKC (N) | 3.46 (1466) | 3.58 (378) | 3.52 (337) | 3.34 (414) | 3.40 (337) |
| Average ICS^a (N) | 20.71 (639) | 23.96 (97) | 21.33 (163) | 20.47 (186) | 18.78 (193) |

^a Integrated Curriculum Scores have been standardized to facilitate comparison between discussion cases

^b The N value refers to the total number of messages

Table 2 mirrors the impact role assignment and types of roles on the dependent variables: the average level of knowledge construction (LKS) obtained by the population and the average ICS score obtained in relation to the four cases. Between brackets, we report the number of messages analysed.

Tabel 2. Descriptives reflecting the relationship between role assignment and the dependent variables.

| | No roles | Roles | Different roles ^c | | | |
|------------------------------------|----------------|----------------|------------------------------|-------------------|----------------|---------------|
| | | | moderator | source researcher | question-asker | summarizer |
| Average LKC (N) | 3.47 (871) | 3.44 (595) | 3.36 (94) | 3.30 (79) | 3.64 (83) | 3.90 (71) |
| Average ICS^a (N) | 20.17 (406) | 21.49 (287) | 21.74 (48) | 21.51 (32) | 18.02 (39) | 23.85 (42) |

^a Integrated Curriculum Scores have been standardized to facilitate comparison between discussion cases

^b The N value refers to the total number of messages of all students in the role condition, including those students not being assigned a role.

^c The total of messages does not equal the Role total of since not all students in the role condition were assigned a role.

The descriptive results in both tables already suggest a differential impact of the independent variables on both dependent measures. This is tested in the next paragraphs.

RESULTS IN RELATION TO THE HYPOTHESES

Hypothesis 1: The nature of the discussion case has a differential impact on the dependent variables: ICS and levels of knowledge construction.

Results of a one-way analysis of variance do reveal significant differences in the average level of knowledge construction due differences in the cases ($F(3; 1462) = 3,052, p = 0,028, \eta^2 = .006$). Partial eta squared points at a rather small effect size. Post hoc analysis reveals that in fact only the Rheumatism case differs marginally significantly ($p=.055$) from the Impetigo case.

Secondly, the analysis results reflect a significant impact of the different cases on the Integrated Curriculum Score ($F(3; 635) = 41,89, p < 0,01, \eta^2 = .17$). Partial eta squared points again at a rather small effect size. Post hoc analysis indicates that all cases differ significantly from one another as to their impact on the Integrated Curriculum Score. Figure 1 gives a graphical representation of the differences in ICS. It is very obvious that the Impetigo case has led to the highest level of attainment of integrated curriculum objectives.

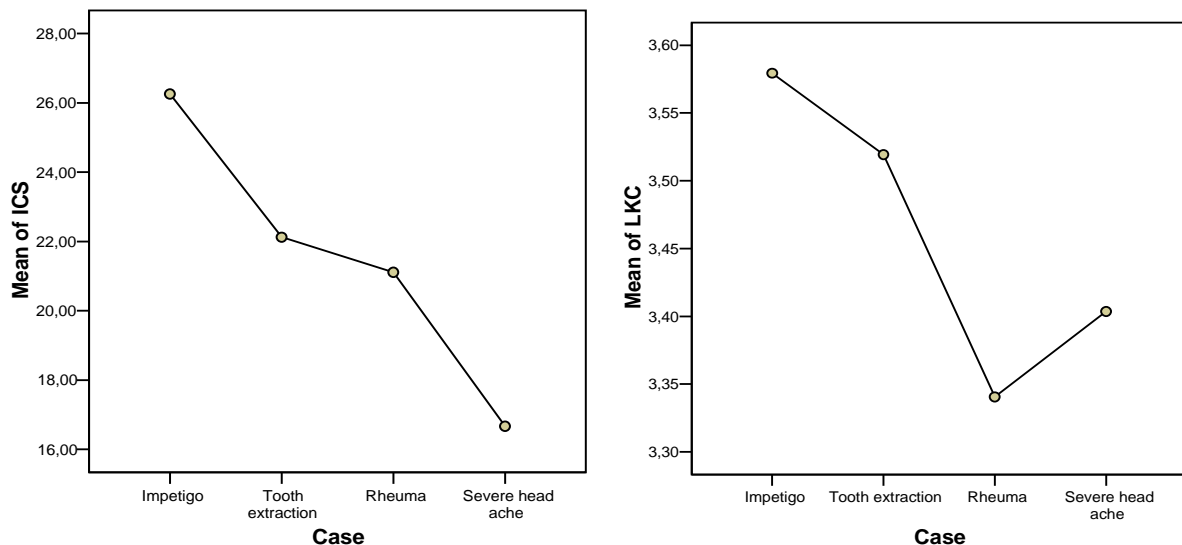


Figure 1. Graphical representation of the impact of different cases on ICS and LKC.

The results of the analyses are in line with findings of other authors that point at the critical nature of the discussion themes, problems or cases in CSCLE (Lockhorst et al., 2002; Strijbos et al., 2004). The results can be explained by a lower level of prior knowledge about e.g., rheumatism or severe headaches. Alternative explanations can be related to task complexity. Possible indicators for this complexity can be derived from the graph about LKC in Figure 1. Parallel to a lower level of ICS, we observe lower levels of knowledge construction. A third explanation refers to the internship context. The last cases were dealt with at the end of the internship when there was a higher task demand on interns to finalize their internship reports, logbook, etc. Students might have been put off by the workload. We return to this in the discussion section.

Hypothesis 2: Role assignment has a beneficial impact on the dependent variables. Groups that are asked to follow role assignments will attain significantly higher Integrated Curriculum Scores (ICS) and/or an average higher level of knowledge construction.

Independent samples t-tests indicate that there are no significant differences in knowledge construction observed when comparing groups with or without role assignment: $t = 0.234$, $p = 0.815$. These results are not in line with our expectation but do reflect comparable negative results in the literature (Schellens, Van Keer and Valcke, 2005). A possible explanation for the unexpected results might be an interaction effect of paying a lot of attention to the structure of the cases. Students in the no-role condition did also receive a lot of guidelines that did sufficiently guide them in discussing and solving the cases. The large attention paid to the task structure might have made the need for clear role assignments less crucial.

The results of the t-tests focusing on differences in Integrated Curriculum Scores point at a significant difference: $t = -2.92$, $p < .01$. Figure 2 represents the differences in a clear way.

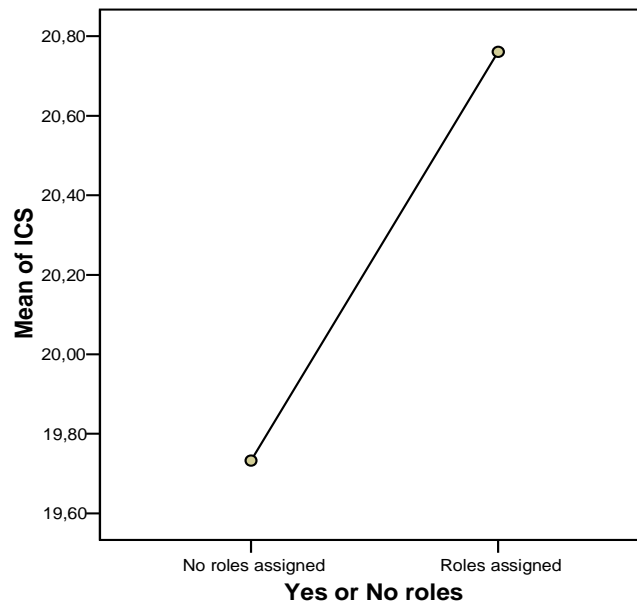


Figure 2. Graphical representation of the impact of role assignment cases on ICS.

As stated earlier, there is little research evidence available that focused thus far on the impact on actual knowledge and skill acquisition. These results are therefore promising and indicate that role assignment has a positive impact on competency development. The question can arise whether the impact of role assignment is still significant when considering the interaction with the cases as independent variable. Additional multivariate analysis of variance (Wilk's Lambda) still points at a significant effect of roles x cases on ICS: ($F(4) = 3.053$, $p < 0,01$, $hp2 = .014$). But it is to be stressed that the effect size is rather small.

Hypothesis 3: The nature of the role assigned to students will result in significant differences in the average level of knowledge construction and/or ICS.

Results of a one-way analysis of variance reveal significant differences in the average level of knowledge construction due to differences in the role ($F(3; 323) = 4,68$, $p < 0,01$, $hp2 = .042$). Partial eta squared points at a very small effect size. Post hoc analysis reveals that the summarizer significantly differs from the moderator and source researcher.

Secondly, the analysis results reflect a significant impact of the roles on the Integrated Curriculum Score ($F(3; 148) = 9,86$, $p < 0,01$, $hp2 = .17$). Partial eta squared points at a rather limited effect size. Post hoc analysis indicates that the question asker consistently performs significantly lower as compared to the other roles. There are no significant differences between the other roles.

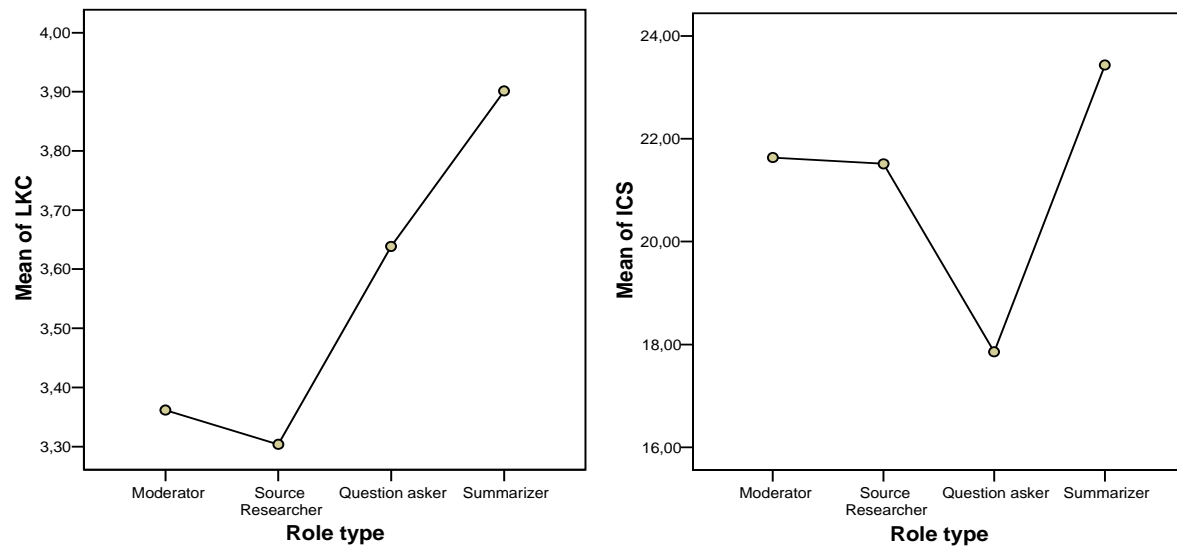


Figure 3. Graphical representation of the impact of role types on LKC and ICS.

The results are consistent with findings in the literature that types of roles do matter and might affect the cognitive processing capacities of students and their learning outcomes. In earlier studies, especially the role of the summarizer was observed to have a large positive impact (Schellens, Van Keer and Valcke, 2005). In Figure 3 we can observe the higher impact of this role on both dependent variables, but yet not always significantly different from the other roles. The present finding is important for developers of learning environments. Although, in the literature, role assignment is presented as an effective structuring approach in CSCLE, certain roles might distract learners from the central objective of the learning task at hand. We can assume that students adopting the role of question asker, focus to a too large extent on the contributions of other students and neglect their personal elaboration of contributions to the discussions that are beneficial for attaining the learning objectives (De Wever et al., 2008). In the latter study it was found that students that – in the context of solving paediatrics cases – were asked to look for alternative approaches, mirrored higher levels of cognitive processing. This was explained by referring to the fact that this role obliges students to adopt a broader perspective when looking at all the other contributions in a discussion. They have to go beyond what is currently available.

DISCUSSION AND CONCLUSIONS

The aim of the present article was to evaluate the impact of an innovative instructional design of internships in view of a new integrated pharmaceutical curriculum. A key element in the innovation was the implementation of a computer-supported collaborative learning environment. Students were – as part of their formal curriculum – expected to work in a systematic and collaborative way in discussing and solving real life cases. Students in the role condition were assigned specific roles. The cases were an additional critical variable in the study.

The results of the study demonstrate that both independent variables – role assignment and cases – have a significant, but modest impact, especially on the attainment of objectives of the new integrated pharmaceutical curriculum (ICS).

But despite these positive findings, some remarks have to be made. Firstly, the effect sizes of the significant differences are rather small. Secondly, and this can explain in part the former, the duration of the quasi-experimental design was short: 10 out of 26 weeks of the internship. In addition, it was the first time that students were involved in this particular way of working and learning. The researcher did not control for differences in prior knowledge about information and communication technologies. In addition, differences in the ICS can partly be explained by differences in prior knowledge of the students. Future studies should control for these initial differences at the start of the study. Nevertheless, the fact that fifth-year students were involved in the study can be put forward as an argument to expect a weaker potential impact of prior knowledge.

A questionnaire was presented to the students to gather some qualitative information about their perception of the strong and weak points of the innovative instructional set up. Students stress the following strengths of the approach: the fact they have to use the Internet, the obligation to integrate knowledge from various domains to tackle the cases, the collaboration with other students and the efficient technical collaboration tool. On the other hand, they report the following negative or inhibiting factors: not all students had straightforward access to a computer and the internet in their internship location, they point at the additional workload that became especially obvious at the end of the internship period, some students in the role condition criticized the fact that they had to adopt a fixed role for all cases and some students would have preferred to receive more case information about the patients.

The results of the present study are promising. In the context of the pharmaceutical educational program of the Ghent University, these results have already influenced the decision to implement the CSCLE in a structural way in the context of the internship period. Again, this instructional approach will be evaluated. At the same time, the researchers will take into account the remarks of the students and the weaknesses observed of the present study in view of developing and adopting sound and evidence-based instructional approaches in pharmacy education as was argued by Beck (2002).

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Chapter 5

EXPLORING THE PREDICTIVE EFFECT OF INDIVIDUAL STUDENT CHARACTERISTICS ON THE LEVEL OF KNOWLEDGE CONSTRUCTION AND THE LEVEL OF INTEGRATED PHARMACEUTICAL KNOWLEDGE IN A COMPUTER- SUPPORTED COLLABORATIVE LEARNING ENVIRONMENT

This chapter is based upon '*Exploring the Predictive Effects of Individual Student Characteristics on the Level of Knowledge Construction and the Integrated Pharmaceutical Knowledge in a Computer-supported Collaborative Learning Environment: an Analysis*' (S. Timmers, H. Van Keer, T. Schellens, W.R.G. Baeyens and M. Valcke), as submitted to Medical Teacher in 2009.

ABSTRACT

This article describes a study building on the implementation of an innovative course in the last year of the pharmacy curriculum of the Faculty of Pharmaceutical Sciences of Ghent University. This new course focuses on the application of integrated pharmaceutical knowledge in a computer-supported collaborative learning environment. In this environment, students adopt roles to work on cases to be solved during the asynchronous discussions. More in particular, the study centres on the effect of individual student characteristics like gender, prior knowledge, but also a number of mediating variables on the level of knowledge construction and the level of integrated pharmaceutical knowledge. The results show that student background characteristics are no significant predictors of achievement. As to the mediating variables, the adequate adoption of the assigned role significantly explains part of the variance in the level of knowledge construction.

Chapter 5

Exploring the Predictive Effect of Individual Student Characteristics on Level of Knowledge Construction and Integrated Pharmaceutical Knowledge in a Computer-supported Collaborative Learning Environment

INTRODUCTION

“Activating prior knowledge is like preparing the soil before sowing the seeds of knowledge”
(Cummins, 2007).

In a series of studies, set up at the Faculty of Pharmaceutical Sciences at Ghent University, the focus was on the evaluation of a curriculum innovation and the implementation of a new course Integrated Pharmaceutical Knowledge (IPK) in the last year of the curriculum. Although the studies did point at the overall positive impact of the curriculum innovation and the specific contribution of the newly developed course, a number of questions remained as to the critical role and/or impact of individual student differences. In the present study, student differences will be considered when studying the achievement scores of students enrolled for the IPK course and when working in an asynchronous Computer-supported Collaborative Learning Environment (CSCLE). We start with a short description of the innovative instructional setting. Next we focus on the potential impact of individual differences and student background characteristics in instructional settings supported with

computer tools. This will be reiterated by focusing on the particular innovation discussed in this article. This will be the starting point to present the research design.

THE INNOVATIVE CURRICULUM AND “INTEGRATED PHARMACEUTICAL KNOWLEDGE”

The adoption of the Bologna declaration (1999), has largely affected the three cycle architecture of higher education. In addition, it has strongly affected the focus towards learning outcomes, recognition of prior knowledge and quality assurance (Crosier et al. European University Association, 2007). The Bologna declaration has largely affected the redesign of the curriculum in the Faculty of Pharmaceutical Sciences at Ghent University. Whereas the traditional curriculum was dominated by lectures, the new curriculum reflects a gradual introduction of interactive, problem based and collaborative instructional formats (see Table 1).

Table 1. Instructional strategies and learning materials of pharmaceutical education at the Faculty of Pharmaceutical Education of Ghent University, in the academic year 2005-2006 (Study Guide, 2005-2006).

| Curriculum year | Learning material | Learning method |
|---|--|--|
| First year | 87,5% uses classic syllabus 12,5% uses classic syllabus combined with scientific articles | 75% formal lectures and practical exercises 25% formal lectures combined with self-study and collaborative learning |
| Second year | 100% classic syllabus | 88,9% formal lectures and practical exercises 11,1% system of PBL |
| Third year | 88,9% classic syllabus 11,1% cases and tasks | 66,7% formal lectures and practical exercises 33,3% system of PBL and self-study |
| Fourth year | 85,7% classic syllabus 14,3% instruction manual for ICT-use | 85,7% formal lectures and practical exercises 14,3% interactive group sessions and self-study |
| Fifth year (courses except for the internship) | 100% classic syllabus | 75% formal lectures and practical exercises 25% interactive group sessions |
| Optional courses for the fourth and the fifth year | 88,9% classic syllabus 11,1% international articles | 88,9% formal lectures 11,1% interactive lectures and seminars |

As can be seen in Table 1 there was clearly room for changes in the way the instruction was designed. The innovative curriculum was – in a next phase - again adapted by the introduction of a new course: Integrated Pharmaceutical Knowledge (IPK) for last year students (2004-2005). The main reason to implement this newly designed course is related to the fact that the role of today's pharmacist has changed (Dunlop and Shaw, 2002; James et al., 2002; Bell et al., 2007). A pharmacist

nowadays should not only master the complex knowledge base related to medicines and diseases. He/she should also be able to communicate and collaborate with other health care workers. Pharmacy education should therefore give students the opportunity to acquire (1) the critical knowledge base and (2) the critical communicative, collaborative and interdisciplinary skills. This is also stated by Veen (1999) who indicates that the main goal of pharmacy education has expanded to include the ability to obtain, judge and assimilate new information, to solve independently (pharmaceutical) problems and to understand the importance of lifelong learning. To answer these demands of today's technological and economic society, there is a growing need to change the instructional approaches.

In the context of the pharmacy curriculum at Ghent University, it was decided to develop the IPK course to cater for these new demands. The course is implemented within the context of an e-learning environment: the Minerva system. This open source package is implemented as a university-wide provision to support every single course in all curricula (minerva.ugent.be) The impact of using the e-learning environment depends largely upon the specific features of the tool that are implemented (agenda, news, roster, assessment tool, collaboration tool, chat tool, shared workspaces, document upload, ...). For the IPK course, a large emphasis was put on the use of the asynchronous computer-supported collaborative learning environment.

The IPK course runs during the second semester of the final curriculum year and in parallel to the five-month internship in a professional pharmacy (mostly in a community pharmacy, sometimes in a hospital pharmacy. Students discuss on-line in groups of 6 to 7 students about patient cases and related pharmaceutical problems.

The students are presented 5 different patient cases combined with in total approximately 100 questions and pharmaceutical problems covering most of the related subjects in the pharmacy curriculum. Students work during 2 weeks on an individual case to develop a shared group solution and conclusion. Students were expected to contribute at least 2 times a week and 4 times to each individual case. As will be discussed below, students contributed far more to the discussions.

The asynchronous nature of the discussions make it possible that the course can run in a distributed way, independent of place and time. This fits nicely with the distributed nature of the internship. The collaborative design of the course requires of both students and teachers to develop new skills, such as knowledge management, problem-solving skills and communicative skills

(Nevejan, 2001). These are expected to underpin the specific skills mentioned in the pharmacy curriculum.

A particular feature of the on-line IPK course is that during the ten weeks of on-line discussions, students are assigned roles. Roles increase students' awareness of their specific collaboration (Strijbos et al., 2004). In a previous investigation concerning the IPK course carried out by Timmers et al. (2008), we could conclude roles have a significant influence on levels of knowledge construction and learning achievement. De Wever (2008) stresses role prescriptions should be very well developed and it should be tested whether students adopt roles as they have been designed. Six different roles are presented to students to discuss IPK patient cases. In Figure 1 these roles are described. Students rotate in the adoption of the different roles. The latter is necessary, considering the differential impact of specific roles on achievement and cognitive processing (Timmers et al., 2008). The students receive detailed guidelines as to the way they have to adopt the specific roles.

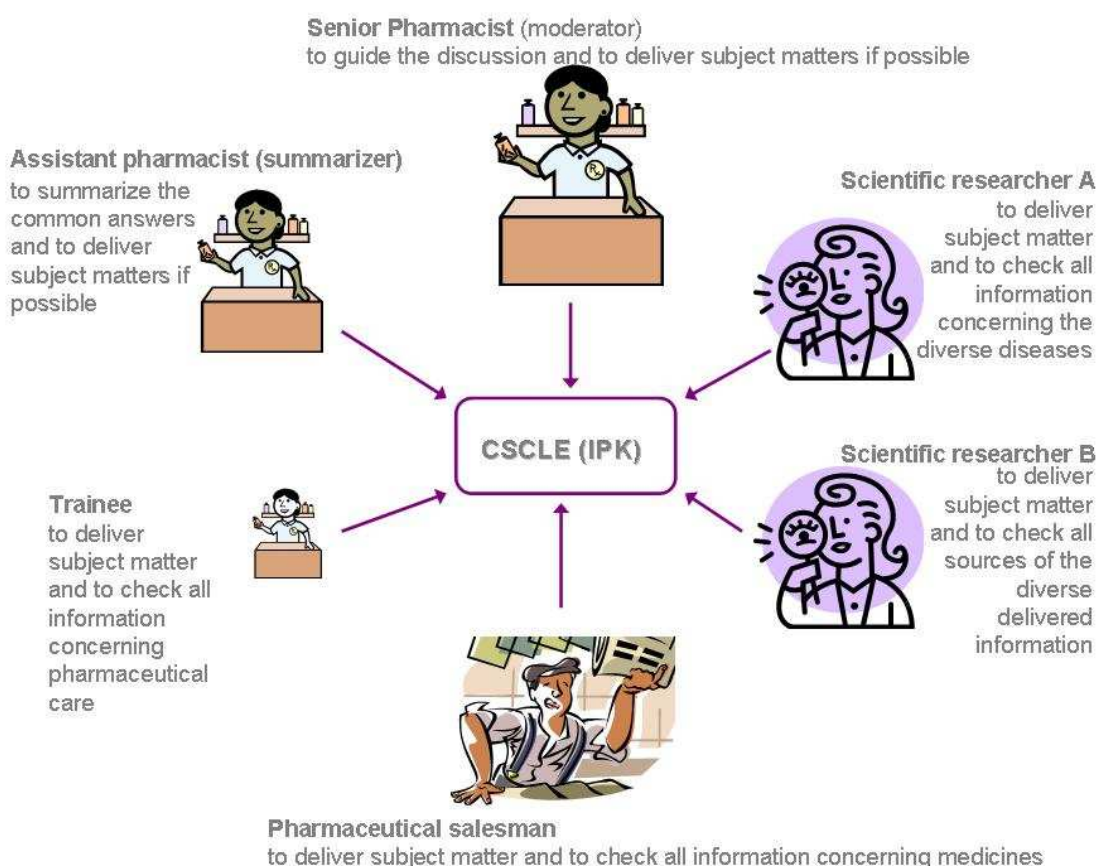


Figure 1. Description of the different roles.

INDIVIDUAL DIFFERENCES IN COMPUTER-BASED INSTRUCTIONAL SETTINGS:

GENDER AND PRIOR KNOWLEDGE

In the literature, a variety of student characteristics is discussed that influence the efficiency and efficacy of instructional interventions. Several authors stress the importance to consider the individual learners' profile of knowledge and skills in educational research (Pellegrino and Glaser, 1979). In the context of this article we discuss gender and prior knowledge state as key background variables.

Barbieri and Light (1992) studied gender differences when working on novel problem-solving tasks on computer. The findings point at differences in the way specific pairs interact with one another. But not only gender played a role, but also pair type (male-male, male-female, female-female) and the verbal interaction measures.

Dillenbourg et al. (1996) studied the effect of manipulating collaboration variables on individual learning measures. They observed an effect of gender and group composition but found this to be different depending on age and specific circumstances. Whitelock and Scanlon (1998) observed differences in CSCL communicating approaches between male and female students. Gender clearly had an effect on the collaboration process; but they could not detect an effect on related achievement. Light et al. (2000) warn for a male dominance in access and use of computer resources when working in mixed gender settings. Hakkarainen (2000) revealed that, using a CSCLE, male students did not collaborate as well as female students; in addition male students dominated the discourse interaction.

Also more generic studies that focus on cultural differences and its influence on attitude and behaviour when using educational Web-based applications it is found that gender plays a role (Sánchez-Franco et al., 2008). But most of these studies also stress that the effect of gender can not be isolated and has to be considered in a total research setting.

A second critical individual characteristic is prior knowledge. As stated by Ausubel (1968, 1978) future learning is largely defined by the available prior knowledge. Activation of prior knowledge makes new learning "meaningful". The latter is critical when designing learning environments: to what extent does the learning environment activate the prior knowledge state of students? The prior knowledge state of a student can be defined as the knowledge that is present

before the implementation of a particular learning task. It is available, recalled or reconstructed for the achievement of a learning task (Dochy and Alexander, 1995; Dochy et al., 1999). Jonassen and Grabowski (1993) present another definition by stressing that it is the knowledge, skills or ability that students bring to the learning environment prior to instruction.

The authors stress that prior knowledge plays a critical role in novices. Nevertheless we can expect that prior knowledge might play a role in the context of the new IPK course, since students have to rely on their mastery of all courses from previous curriculum years. According to Yazon and Redfield (2002) the medium changes the message. They concluded that a carefully designed learning environment, that combines face-to-face and on-line elements has the potential to assist students in thinking differently about teaching, learning but also about the subjects that have been taught. In other words, making use of on-line learning environments might have the potential to activate the prior knowledge of learners.

Tuckman (2002) investigated for instance ADAPT, a hybrid instructional model that combines web-based and classroom components, in which he took into account past performance of students. The focus on prior knowledge is of particular relevance in the context of the IPK course. Whereas the discussion about prior knowledge has especially been stressed in relation to starting students, the present study involves advanced level students. Little research is available that has centred on the role of prior knowledge in computer-based learning environments that focuses on these advanced level students.

It is to be stressed that also other individual differences can play a role in a computer-based setting (Vance Wilson, 2000). Holt (2000) stresses e.g., the influence of prior negative experiences with computer-based courses. A variety of variables play a role in this context. Benson Song, (2001) mentions e.g., the fit between a particular technology use and the teacher, the technical competences of the instructors and the students, their beliefs and conceptions about learning, the level of IT-infrastructure and technical support, and so forth.

Chou Huey-Wen (2001) studied the impact of cognitive style on educational achievement and the impact of the instructional approach on learners' computer self efficacy and learning performance. Lin Binshan (2001) stresses the need for more studies about the interaction between learning styles and course design. It is hardly possible to study or control for all individual differences in a research design. Nevertheless, we expect that a number of these differences will be of smaller importance; for instance prior experiences with computers, experience with technology and

computer competences. The advanced level of the students and the established nature of the e-learning environment in the curriculum suggest that these variables might be of lesser importance. We also hypothesize that cognitive style and learning style will play a more restricted role since we involve fourth year students. Research suggests that more advanced students, and students in medical domains are more likely to reflect a homogeneous learning style or cognitive style due to the nature of the study and the assessment processes (Davis, 1995; Desmedt, 2004). Nevertheless, other individual differences might play a role. Therefore, the research design will aim at measuring and/or controlling a number of these variables to be able to map the particular impact of a basic set of individual differences.

RESEARCH DESIGN

An exploratory research design was adopted to study the key research question: What is the impact of individual differences on cognitive processing and learning achievement in the IPK context?

PARTICIPANTS

Participants in the present study represent the entire population of fifth-year students enrolled during the academic year 2205-2006 in the pharmaceutical sciences (N = 73). The study was set up in relation to the IPK course and the internship described above. Students were randomly divided into groups of 6 or 7 students (11 groups of 6 students and 1 group of 7 students).

As stated earlier, gender and prior knowledge are considered as key variables that determine individual differences. We observe that 17 of the students are male (23,3%) and 56 of the students are female students (76,7%).

The individual level of prior knowledge is - in the context this study – defined as the attainment level after finalizing the fourth year and the first semester of the fifth year in the pharmacy education curriculum. The individual prior knowledge score (IPrKnS) is calculated as the standardized sum score of all these courses. This calculation approach is in line with approaches of other authors (Dochy et al., 1999). The latter study also revealed that it was not relevant to include in the prior knowledge state measurement personal and contextual indicators such as motives or study time. Since all students have successfully attained the credits for the prior courses, we can consider all students to be equal as to the starting position to take the internship and the new IPK course. This is in contrast to other researchers who studied the influence of the prior knowledge state in view of different opportunities given to the study population (Moerkerke and Dochy, 1998).

CONTROLLING FOR OR MEASURING MEDIATING VARIABLES

Since the study builds on a collaborative learning design, group size and group composition can play a role. Prior research underpins the importance of group characteristics to foster intensive group interactions and related achievement (Dillenbourg et al., 1995). A critical variable is group size. In a quasi-experimental study (Schellens & Valcke, 2006) compared the impact of different group sizes on cognitive processing in a CSCL-setting. Groups with about 8 to 10 group members achieved the highest level of interactivity and attained the highest proportion of high levels of knowledge processing. This number of participants seems to be needed due to the asynchronous nature of the discussions and the fact that explicit information is to be presented to develop the discourse. In the present study we fix the number of participants to 7 students. In view of traditional collaborative (non-CSCL) activities, researchers present evidence that a group size of 4 to 5 participants is the most effective, because otherwise the individuals will not have sufficient opportunities to engage (Johnson et al., 1998; Nurrenbern, 1995).

Other group-related studies centre on the nature of group composition. Since the results of these studies are contradictory, we randomize group composition to obtain heterogeneous groups (Schellens et al., 2004).

A number of variables cannot be made constant. Therefore they are to be measured and taken into account when analysing the relationship between background variables and dependent variables. First, we focus on the individual message score (IMS). IMS is defined as the amount of task-oriented messages that are submitted in the discussion (Veerman and Veldhuis-Diermanse, 2001) during the ten weeks of on-line IPK-discussions. Also Schellens and Valcke (2006) point at the critical impact of IMS. The higher the level of interactivity, the higher the related level of cognitive processing. Also Grabe and Sigler (2002) found that the usage-level of an on-line study tool was related to examination scores.

Since students adopt a specific role during the discussions, question can be asked as to the reliable take-up of the roles. The individual role score (IRS) reports how well students have performed their assigned role. Since roles are expected to have a significant impact on cognitive processing and learning achievement, control of this variable is even more critical (Timmers et al., 2009; Schellens et al., 2005). A specific standardization strategy was adopted to score the performance of the role for each student; this is presented in Table 2.

Table 2. Standardisation of IRS.

| IRS | Performance of the student |
|-----|--|
| 0 | Student does not contribute during the two weeks of on-line discussion of the case, therefore there is no role performance |
| 2 | Student contributes during the two weeks of on-line discussion of the case, but forgot his/her role |
| 2.5 | Student contributes rather rarely during the two weeks of on-line discussion of the case according to the obliged role and posts little extra task-oriented messages |
| 3 | Student contributes mainly in view of his/her obliged role, but posts little extra task-oriented messages |
| 4 | Student performs his/her obliged role correctly during the two weeks of on-line discussions of the case and posts extra task-oriented messages |
| 5 | Student performs his/her obliged role almost perfectly and took a lot of initiative to post extra task-oriented messages to keep the on-line discussion going |

DEPENDENT VARIABLES

As mentioned earlier another aim of this research is to explore the relationship between individual differences and achievement. This implies that the dependent variables in the present study are the level of knowledge construction and the integrated pharmaceutical knowledge score or content score students. The first dependent variable is the Group Integrated Knowledge Score (GIPKS). This is the standardized score obtained after analyzing all the input of group members to the pharmaceutical problems and questions presented during the on-line discussions. Due to the collaborative nature of the discussions, it is not possible to attribute a specific relevant answer or solution to an individual student. Therefore, a group score is calculated. The GIPKS was calculated by scoring the answers to the questions about basic knowledge with a maximum of 1 point; when students had to present examples or extra sources, this was scored with 2 points; the answers, concerning integrated thinking questions (linking different courses), were scored with 3 points and answers to complex questions were scored with a maximum of 4 points.

Secondly, we calculated for each individual student their level of knowledge construction (ILKC). All messages posted during the ten weeks of on-line discussions were coded to determine the individual LKC of the respective students. Seven independent coders carried out the task to code 6639 messages (30786 lines) posted by the students. To be able to check interrater reliability, 10% of the messages were coded by all coders. The results of this comparison are summarized and presented in Table 3.

Table 3. % of agreement looking at the interrater reliability.

| Interrater | % of agreement |
|--|-----------------------|
| Encoder 1 (total amount of messages) - Encoder 2 (messages of group 1) | 70.4 |
| Encoder 1 (total amount of messages) - Encoder 3 (messages of group 2) | 83.2 |
| Encoder 1 (total amount of messages) - Encoder 4 (messages of group 3) | 75.8 |
| Encoder 1 (total amount of messages) - Encoder 5 (messages of group 4) | 88.9 |
| Encoder 1 (total amount of messages) - Encoder 6 (messages of group 5) | 92.4 |
| Encoder 1 (total amount of messages) - Encoder 7 (messages of group 6, 7, 8) | 86.9 |

The interrater reliability can be considered high. Although no decisive cut-off value is presented in the literature, most studies report that proportions above 70% are considered to be reliable (Rourke et al., 2001; Neuendorf, 2002).

The coding scheme was based on the method presented by Veerman and Veldhuis-Diermanse (2001). A distinction is made between task-oriented messages that contribute to knowledge construction, and non-task-oriented messages (see also Schellens et al., 2005).

Non-task oriented messages focus on: planning (“Let’s tackle this topic first!”), technical issues (“How can I integrate a picture in my text?”), social issues (“Good job!”), or nonsense (“Let’s have a pizza tonight.”). Task-oriented contributions can be considered as stages in a knowledge construction process. Figure 2 represents the taxonomical structure of the coding categories.

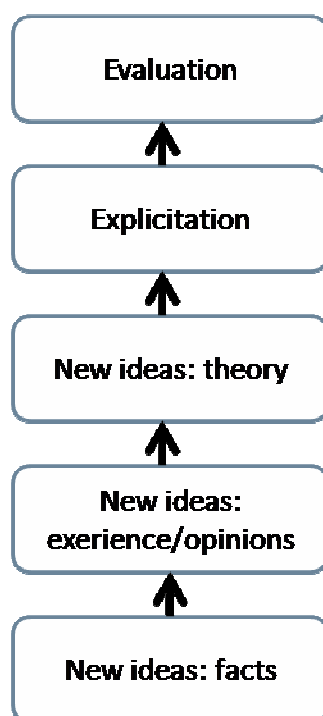


Figure 2. Taxonomical structure of the coding categories in the model of Veerman and Veldhuis-Diermanse (2001).

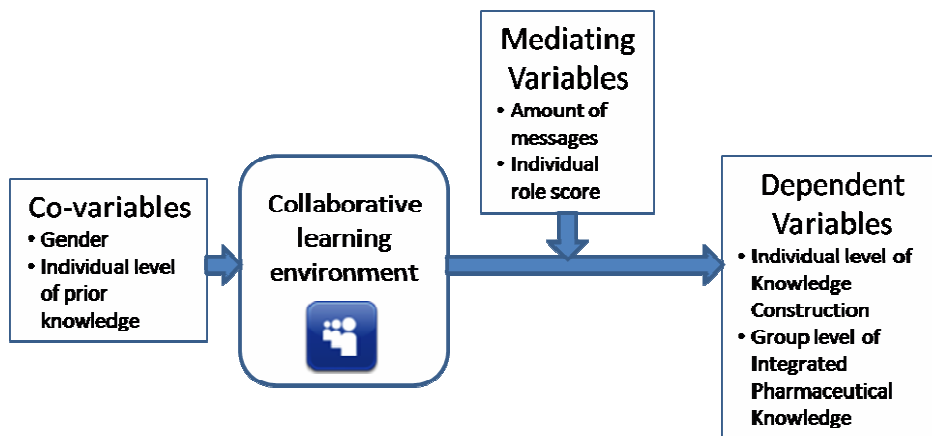
In view of the present study, we focused on the task-oriented messages and scored them according to their “level” from 1 to 5. This means that an evaluative contribution receives a 5 point score. Simply contributing to the discussion by adding a new author or resources, received a score of 1.

Table 4 summarizes the background variables, and the mediating and dependent variables in our study.

Table 4. Background, mediating and dependent variables in the present study.

| Variable label | Variable name | |
|----------------|---|--|
| IPrKnS | Individual Prior Knowledge Score | The standardized Total of all the course results of the fourth year and the First semester of the fifth year in the pharmacy curriculum. |
| IMS | Individual Message Score | The Total amount of messages submitted by an individual student. |
| IRS | Individual Role Score | Evaluation and scoring of the level of adoption of a specific role. |
| ILKC | Individual Level of Knowledge Construction | Average knowledge construction level of all the messages submitted in the discussions. |
| GIPKS | Group Integrated Pharmaceutical Knowledge Score | Total score of the Group that reflects the mastery of the Integrated Pharmaceutical knowledge base as reflected in the discussion contributions. |
| GLKC | Group Level of Knowledge Construction | Average level of knowledge construction of all group members in a discussion group. |

The interplay between the different variables is represented in Figure 3.

**Figure 3.** Interplay between the different variables in the present study.

RESEARCH QUESTIONS AND HYPOTHESES

The general research question is whether individual differences (background variables and mediating variables) have an impact on the level of knowledge construction and academic achievement. This implies that we focus on the impact of background variables and/or mediating variables. Since individual participants can – next to background related differences – also differ in

the way they are involved in the collaborative activity (IMS amount of messages) and the extent to which they take up their role (IRS Individual Role Score), we can expect to observe significant differences in dependent variables (GIPKS, ILKC).

Building on the theoretical and empirical basis, presented above, we hypothesize that differences in background and mediating variables will result in significant differences in levels of knowledge construction and academic achievement.

RESULTS AND DISCUSSION

To answer the research questions about the possible impact of individual student characteristics and the mediating variables on LKC and IPK, a multiple regression analysis was carried out. Two background variables (gender and prior knowledge IPrKnS) and two mediating variable (IMS and IRS) are entered as predictors in the regression.

Table 5. Results of the multiple regression analysis.

| | | LKC | | IPK | |
|-------------------|--|----------|-------------------------------|----------|-------------------------------|
| ANOVA | | <i>p</i> | <i>R² adjusted</i> | <i>p</i> | <i>R² adjusted</i> |
| Regression | All predictors (gender, IPrKnS, IMS and IRS) | .228 | .024 | .416 | .000 |
| | Gender | .526 | | .764 | |
| | IPrKnS | .571 | | .604 | |
| | IMS | .398 | | .122 | |
| | IRS | .056 | | .543 | |

The results in Table 5 are clear. The background and mediating variables (gender, IPrKnS, IMS and IRS) do not significantly predict the individual level of knowledge construction or the academic achievement level. The adjusted R squared values are very low and not significant. However, we observe a single significant predictor effect of the individual role score (IRS) on the individual level of knowledge construction ($p = .056$). An additional linear regression with IRS as the single predictor results again in a significant prediction of the individual level of knowledge construction ($F = 4.18$; $p = .045$). Based on the adjusted R square ($R^2 = .056$), we can conclude that 5.6% in variance in individual knowledge construction depends on the extent to which participants take up their specific role in the discussion groups.

The results indicate that gender and prior knowledge do not play a significant role and also the mediating variable – individual message score – do not have an impact on academic achievement and the level of knowledge construction.

The results about the impact of prior knowledge are not in line with other research. Dochy (1992) and by Moerkerke (1996) clearly found that the amount of prior knowledge predicts future study results. But the studies of the latter authors were carried out with novices who started in a relatively new knowledge domain (economics, medicine). In the present study, the participants are enrolled in the final stage of a five-year curriculum. It can be hypothesized that differences present at the start of their pharmaceutical educational career, have faded. The same way of reasoning can be applied in relation to the variable gender. Initial differences between male and female participants can be overruled by the shared long lasting educational experience. A last third explanation for the conflicting results can be related to the overall high performance of the CSCL groups ($M_{GIPKS} = 6.73$, $\sigma = .38$). Due to a ceiling effect, it is therefore less likely to find significant differences.

It is surprising that the amount of messages is not a significant predictor for LKC or IPK. This is clearly a contrasting result as compared to the findings of Schellens and Valcke (2006) or De Wever (2008). We can explain the conflicting results in a number of ways. First, we can point again at the advanced level of the participants involved in the study. It is possible that a lower contribution level does not automatically mean that a lower processing level of achievement is in play. These students are already able to communicate in an analytic and synthetic way. A single high quality contribution can have the same impact as a series of messages that reflect the gradual development of insight in a student. The minimum messages per case posted by an individual student is 4.20 and the maximum is 27 ($\sigma = 5.52$).

Secondly, the evaluation criteria may have played a role. Since the evaluation criteria stressed a minimum number of messages, most students hardly at least achieved this minimum.

Only the adequate performance of the assigned role was a significant predictor for LKC. This corresponds to results found in other studies concerning role assignment and achievement of LKC. Strijbos et al. (2004) also concluded that roles have an effect on the achieved level of group efficiency. This is in line with the findings of De Wever (2008) who stated that performing different roles might be important for attaining a level of knowledge construction. He could empirically conclude that the extent to which the role performance is in line with performance guidelines has a clear influence. This result strengthens the conviction that during on-line discussions role assignment

is an important feature. This also reconfirms in an indirect way the positive impact of role assignment to students in CSCL as reported in an earlier study (Timmers, et al., 2008), and the differential impact of different roles. Since different roles imply a different level of engagement, they seem to have a differential effect on the level of knowledge construction. We can add to the latter the finding of Schellens et al. (2005) assigning roles to the students is also a motivating factor. Although motivation was not studied as an individual variable in the present study, we can hypothesize that roles do not only have a cognitive impact, but also a social-emotional impact influencing the expectations and the value attached to the group task by the group members.

DISCUSSION AND CONCLUSIONS

Although random assignment of individual students to groups in a collaborative learning environment is expected to control for individual differences, the research literature points at the potential impact of background and mediating variables. Since most of earlier studies focusing on CSCL were mainly set up by involving novices, empirical evidence about the direct of interaction effects of individual differences is scarce.

The results of the research are conclusive. The performance of advanced level students is hardly affected by background and mediating variables. Gender and prior knowledge do not seem to play a role in these advanced level student that nearly finalized their curriculum.

This also points at the generic impact of the innovative pharmacy curriculum that seems to succeed in developing a sound knowledge base in all students before they start the final phase of their training: the internship.

The only significant predictor in the present study is the extent to which participants take up a role that was assigned to them. This is an important and relevant finding. Although all groups in the present study attained a high performance level, the individual level of role engagement still matters. This is a reassuring finding. Whereas some research points at drawbacks of group work (loafing, free riding), role assignment seems to be able to track such a possible variation in involvement (Piezon and Donaldson, 2005). The latter also implies that in the context of the innovative IKP course, a careful introduction and monitoring of roles are needed.

ACKNOWLEDGEMENTS

All the encoders (Sarah Haentjens, Laure Geslin, Julie, Geertrui Vandercruysse, Anneleen Van der Jeught and Marijke Dhondt) who did a re-encoding (for quality assurance of my own encoding work) and took therefore half of the almost 7000 messages for their account should be thanked.

Prof. H. Van Keer and Prof. T. Schellens for their input as to educational theories and their patience.

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GENERAL CONCLUSIONS

General Conclusions

GENERAL CONCLUSIONS

In this final chapter, the research findings of the studies presented in this dissertation will be integrated and discussed at a general level to find out what we have learned, what the implications are, what the limitations of this research work are, which points of interest will need further investigation and finally what the overall conclusion is.

We will start this final chapter by summarizing the most important discussion items and results to find a solution for the general research objectives outlined in Chapter 1.

RESEARCH FOCUS

As the title of this dissertation implicates, the central focus of the study was to analyse whether the implementation of an innovative pharmaceutical curriculum in general and a new course Integrated Pharmaceutical Knowledge (IPK) in particular have an impact on the readiness for the pharmacy profession.

Although in the literature several learning advantages have been described for implementing new instructional techniques like problem-based learning, task-based learning, case-based learning using the possibilities offered by information and communication technologies, there was little literature available about the long-term effect of these adaptations; especially in the pharmacy education context (Latif and Berger, 1999; Reddy Indra, 2000; Reeves and Francis, 2001; Cisneros et al., 2002; Marriott, 2007; Black and Plowright, 2008; Hyvärinen et al., 2008; Van der Veken et al., 2008).

To be able to carry out a solid research study, an introductory review of the literature was needed. But as the literature review revealed that there was no instrument or questionnaire available to investigate the impact of educational changes on the students' readiness for professional life in a pharmacy, we decided to design and develop an instrument called the 'Internship Experience Scale' (IES). The design process was based on the adapted final attainment levels of the new

pharmacy education curriculum and the pharmacy internship goals (Final Attainment Levels, 2002; Remon and Van Tongelen, 2004).

As the IES instrument was found reliable and valid (see Chapter 2), it could be used to examine the impact of educational innovation in general and the newly developed IPK course in particular with a specific focus on the fifth year of the pharmacy education curriculum.

Another focus of this dissertation was to investigate the instructional design of the course IPK, partially taught via a computer supported collaborative learning environment (CSCLE). Although positive results and various advantages are linked to using a CSCLE in a higher educational setting (Bernard and Lundgren-Cayrol, 2001; Schellens and Valcke, 2005), no empirical evidence is yet available as to its implementation in a pharmacy internship setting.

OVERVIEW OF THE RESEARCH QUESTIONS AND RELATED RESULTS

As described in the dissertation, four fundamental research questions were formulated in the different chapters. An overview of the research focuses of the different chapters and the related results are described below:

Chapter 2: Can we design and develop a valid and reliable instrument to monitor the impact of the implementation of the innovative course Integrated Pharmaceutical Knowledge (IPK) in the pharmacy education curriculum?

Considering the adapted final attainment levels of the pharmacy education curriculum and the particular internship outcomes as established by the Faculty of Pharmaceutical Sciences, there was a need to develop a specific instrument to monitor the growth in student readiness. The clusters of items in the new instrument reflect the variety of tasks of a “modern” pharmacist. As a result, the “Internship Experience Scale” (IES) was based on 53 statements concerning the organisation in a pharmacy, staff management, medical prescriptions, magistral preparations, pharmaceutical care and providing information to the patients, medicines and legislation and deontological matters. The reliability of the IES instrument was tested and was found to be high with an average Cronbach’s alpha of .95. Looking at the way the IES was developed and keeping in mind that several experts were consulted, it can be concluded that this grounds a good level of content validity of the IES. The

factor analysis, based on a principal component analysis, revealed that the resulting pattern largely mirrors the theoretical structure that directed the design of the instrument.

Chapter 3: What are the long term consequences of the implementation of the course IPK on the final attainment levels and the internship outcomes of entry-to-practice pharmacy students?

On the basis of a cross sectional longitudinal analysis of IES scores, gathered for five successive years, it was found that there is a significant change over time in cluster scores of the IES. A further analysis was needed to determine in a more detailed way when the significant changes could be observed. A post-hoc analysis indicated that the largest impact of the implementation of the IPK course was observed in the academic year when it became a formal part of the pharmaceutical curriculum. Before that date, an experimental version of the IPK course was used, resulting in a lower impact. After its formal implementation, a steady increase in IES scores was observed, but this increase is no longer significant. By analysing pre-internship and post-internship IES scores (paired sample t-test), we could determine that the strongest impact of the IPK course implementation was detected in the academic year 2004-2005. After this academic year – although some minor course adaptations were introduced - no additional significant changes in dependent variables were produced. Nevertheless, also in the academic year 2005-2006 the impact of the IPK course is remarkable due to instructional innovations integrated from that time on.

Chapter 4: Do role assignment and the nature of the pharmaceutical cases presented in the context of the IPK course via the CSCL environment, have a significant impact on the level of knowledge construction and on academic achievement of pharmacy students?

Results of an analysis of variance test revealed that the pharmaceutical nature or content of the patient case has a significant influence on the achieved level of knowledge construction and on the integrated curriculum score or integrated curriculum score (ICS).

Considering the potential positive effect of role assignment in the asynchronous computer supported collaborative learning environment, analysis results indicate no significant differences in academic achievement (integrated curriculum score). However, the results of the study clearly demonstrate that both independent variables – role assignment and cases – have a significant impact on levels of knowledge construction and especially on the attainment of objectives of the new integrated pharmaceutical curriculum.

Additional analysis of variance learned that the nature of the role is important. It is remarkable that the summarizer role result in the largest positive impact, and that this is clearly different from the moderator and the source researcher role.

Chapter 5: Do individual student characteristics, e.g., gender, individual level of prior knowledge, individual amount of messages posted during the on-line discussions, and the individual role performance score, predict in a significant way the level of knowledge construction and academic achievement when working in a computer supported collaborative learning environment?

The results of this research revealed that the individual student differences, such as gender, individual level of prior knowledge, individual amount of messages and individual role performance score do not have an overall combined significant impact on academic achievement and the level of knowledge construction. However, the individual role performance score, a mediating variable, does have a significant – but rather low - predictive influence on achieving level of knowledge construction.

IMPLICATIONS

As researched in the present dissertation, the development of new courses and the adoption of innovative instructional techniques being adopted to improve higher education, should always take into account the nature of the curriculum. In the present studies, a strong emphasis was put on the particular characteristics of the the pharmacy curriculum. This implied a strong emphasis on basis pharmaceutical knowledge and on basic pharmaceutical competences.

Due to the rapid and constant changes in the health care profession and the environment, the pharmaceutical education curriculum is continuously challenged to meet the new requirements (Tromp, 1999; Leemans and Laekeman, 2000).

Considering the former perspective, the academic world should constantly refine the educational process to be able to answer these changing needs. Integrated Pharmaceutical Knowledge (IPK) is a course with sufficient room for making changes and adaptations. The results of the studies presented in this dissertation are encouraging, indicating that the newly developed IPK course presents an added value to the pharmacy education.

However, since the faculty bears responsibility to ensure that the curriculum meets the evolving demands of society, a continuous quality monitoring process should be adopted. This implies that the outcomes of the curriculum are regularly monitored, and that also specific courses (such as IPK) are evaluated. The final aim is to guarantee that graduated pharmacists are well prepared to lead advances in practice and to adapt to the continuous demands of their professional career.

LIMITATIONS

Despite of the encouraging research results, some limitations of the reported investigations should be considered.

TYPE OF BIAS

The IES instrument was developed on the basis of 53 items, but in the longitudinal research studying the impact of the educational innovation over a five year period of time, some items had to be excluded. The items concerning staff management were left out. Hence it could be interesting to adapt the IES or to update the items so that they can be used in a future IES-version.

The students of the last year, involved in the different studies of this dissertation, were informed about the study during an introduction session. The fact that they were informed and that informed consent was obtained, might have caused response bias. Nevertheless, we think that the long lasting nature of the research set-ups (during the internship) might have countered this.

A third limitation that has to be considered is related to the coding of the messages posted by the students during their on-line discussions. Since only one educational researcher is available in the Faculty of Pharmaceutical Sciences, this same person had to encode all the messages. Since the literature stresses the importance to involve multiple independent encoders and the need to check the interrater reliability extra coders were recruited (De Wever et al., 2008). This implied the training of master students and a pharmacist, also involved in IPK, in view of the coding task. The differences in expertise and background can have caused some bias. Nevertheless, the interrater reliability reported in both chapters 4 and 5 was high, so this issue is not of immediate concern. Nevertheless, in the future it would be advisable to work with a more homogeneous group of researchers to tackle the time consuming coding task.

Next, only in the fourth study did we centre in a more profound way on the potential interaction between individual differences and the dependent variables. We have to recognize that other variables and processes might have affected the results. The regression analysis results suggest that the variables included in the analysis had – at maximum – only an isolated and limited impact. This can suggest that the major impact was caused by the actual learning process and as such by the involvement in the learning environment. Nevertheless, additional research is needed to look why even successful students still differ in their outcomes and what individual variables play a role in this context. This could help to update future versions of the innovative curriculum and innovative courses.

Fifth, the target group of the studies discussed in this PhD thesis were fifth year students. There is no doubt that it would be relevant to implement a number of the innovative features discussed here at an earlier stage in the pharmacy education curriculum.

Lastly, an attempt was made to develop quasi-experimental research designs in the context of the ongoing educational process. The research requirements had to be carefully balanced with the demands of the actual educational process and the needs of the individual students. This made it impossible to completely randomize students in all conditions, to control for processes and variables that mediated in the instructional setting (e.g.; other courses, the nature of a particular student internship, contact between students beyond the on-line collaboration, etc. Nevertheless, we think that there is a real need for the way the current studies have been set up. They prove in this way that the innovation is sufficiently robust to withstand the way higher education is continuously influenced by uncontrolled variables, planning interference, fostering conflicts, illnesses of experts, and so forth.

DIRECTIONS FOR FUTURE RESEARCH

Above, some future directions for research in the context of the Faculty of Pharmaceutical Sciences at Ghent University have already been presented.

The research reported in this PhD thesis illustrates the large importance to involve representatives from the professional pharmaceutical field in educational innovations. This means that educational research should build on an improved communication between the academic and the professional field. Representatives from e.g., community pharmacies could contribute to

websites that keep track of pharmaceutical care issues. This cooperation can also contribute to interprofessional education and build a trustworthy collaboration with professionals from the health care sector (Miers et al., 2007; Carbonaro et al., 2008; Nisbet et al., 2008).

Considering the educational innovations at faculty level, it could be interesting to implement novel approaches to assessment and evaluation. Considering the professional competences of pharmacists that have to be self-reflective, and to (re)consider their courses of action, it might be relevant to develop and introduce these skills during their education. This could be done by applying self assessment and peer assessment. This could be integrated into, for instance, the small group work during the IPK course. The continuous embedding of peer assessment can help to develop a reflective attitude in future professional pharmacists. It might also make students better aware of the specific criteria and indicators that apply to the outcomes concerning basic pharmaceutical knowledge and skills of a specific course.

In addition, since the e-learning environment Minerva of the Ghent University offers a large number of possibilities, it might be interesting to use the possibility of electronic portfolios for certain courses in this context. At this moment some faculties at Ghent University already experiment with this self-reflective portfolios (see e.g., teacher education programmes).

In the near future, there are plans to design and develop a new practice-related course to integrate the basic pharmaceutical knowledge during the three Bachelor years. Also in this course, students will have to work in small groups. They will have to follow the production process of a well-defined given medicine, from synthesis to the completed final product. As this course will integrate different disciplines and students will have to work in limited groups to come to a common conclusion, the results of this dissertation can be partially reused and kept in mind. In addition, we will have to centre in particular on the interplay between individual differences, since this implies a shift to a more novice student population.

EVALUATION OF THE IPK COURSE BY THE USERS

Evaluation of the IPK course by the target group, the students, is helpful to adjust and further develop this course for the future. IPK is a dynamic course, which should constantly be adapted to external and internal educational needs.

As can be observed in Table 1, where a selection of results from an electronic survey is presented, the overall opinion about the IPK course is positive. Survey results were gathered after discussing on-line about 4 cases during 8 weeks of the second semester. All students filled in the survey, although it was not an obligation. Despite the positive results, there are issues to be taken care of. The most eye catching remarks are the ones about the extra workload of the students. In the future it is therefore interesting to set up additional research to control for a realistic workload and, if necessary, to develop adjustments.

Table 1. Interesting statements of the survey held in the academic year 2004-2005 after discussing on-line about 4 presented patient cases and related problems during 8 weeks of the second semester. All students filled in the survey, although it was not obliged.

| | % of the students who | | | |
|---|-----------------------|---------------------|------------------------|-----------|
| | agreed | more or less agreed | more or less disagreed | disagreed |
| By participating in the on-line discussions I have learned new information | 40 | 53 | 1 | 6 |
| Working with real life patient cases and concrete applications, helped to better understand the content of several instructed courses | 52 | 37 | 8 | 3 |
| I found participation in the on-line discussions a good preparation for the professional life in a pharmacy. | 30 | 45 | 18 | 7 |

At the end of the survey, students could also add personal comments about the IPK course. Almost all students took the opportunity to phrase a personal opinion. Some eye catching comments are presented below:

- “This was one of the courses that I liked the most and that was of the highest use to me now as a trainee, but I will keep it in mind as a professional pharmacist.”
- “It was a very informative course.”
- “A very good initiative to implement real life patient cases in the education.”

- “I found it very interesting that finally our theoretical knowledge base could be applied to analyse the patient cases.”,
- “It involved too much work combined with our internship and so I’m afraid I didn’t learn enough.”
- “It was not always easy to communicate with our fellow-students and finally come to a common conclusion, but we learned how to deal with those problems and learned from it.”.

To CONCLUDE

We keep repeating that it is of utmost importance that higher education stays in tune with new developments in the professional, scientific and educational domain. Pharmacy education is no exception to this requirement. In addition, we stressed continuously throughout this PhD that adaptations, changes, innovations should be monitored as part of a larger quality assurance cycle.

The adaptations and updates of pharmacy education are necessary to deliver entry-to-practice pharmacy graduates who can meet the standards of the constantly evolving health care society and to “protect” the public or patients.

A reassuring general conclusion can be derived from the present dissertation: the educational innovation of the pharmacy curriculum in general, and the development and implementation of the new course “Integrated Pharmaceutical Knowledge (IPK)” have resulted in positive and at least promising results. As could be derived from, for example, the longitudinal research study entry-to-practice students report a higher attainment level in specific pharmacy competences. In addition, the other studies that build on ICT, also demonstrate how the adoption of innovative instructional strategies has resulted in more sophisticated cognitive processing and/or higher achievement levels.

The newly designed case-based IPK course was investigated by focusing on group allocation, group composition, the assignment of roles and the nature or content of the patient cases. We can conclude that groups of 6 to 8 students are effective and that a random allocation to groups guarantees heterogeneity. The assignment of roles did not yet result in significant gains in academic achievement, but nevertheless did result in significant higher cognitive processing in view of the processing of integrated pharmaceutical knowledge. But as described in the literature, if role assignment is accompanied by specific guidelines and a rotation in roles is guaranteed, it is quite

motivating for students to be involved in the collaborative activities and to come to constructive discussions (Strijbos et al., 2004; Schellens et al., 2005; De Wever et al., 2008).

Last but not least the findings, that the outcomes of the curriculum in general and the IPK course in particular are not significantly affected by typical individual differences (e.g., gender, prior knowledge), are no longer relevant in students starting their last curriculum year.

The innovations, discussed here, that build on the initiatives taken at Ghent University and the Faculty of Pharmaceutical Sciences are not isolated from a broader discussion. Also the other European Faculties of Pharmacy (EAFP) are putting substantial efforts in educational innovations and evaluative research that is set up in parallel (see e.g., the annual meeting of the European Association of Faculties of Pharmacy concerning pharmaceutical education). Recently “Pharmacy Education in Europe or PHARMINE” – a project of the EAFP recently approved by the European Commission - is a relevant example to show how important higher education and continuing education is for (future) pharmacists. In the European context, it has become an accepted higher education goal to further the principles of the Bologna declaration (1999). In the context of the pharmacy education curriculum, this means – among other things – that three important areas of pharmaceutical expertise have to be dealt with: community, industry and hospital (EAFP on-line, 2009).

Although ICT use has become “trendy” in higher education, we can conclude that these trends have become an evidence-based practice in pharmaceutical higher education. The clear emphasis on evaluative research and quality assurance has been a catalyst to attain this quality level in pharmacy education. Though the innovative practice researched in this PhD sound new, they also echo old ideas and aspirations. Apparently, Benjamin Franklin was already correct in the late eighteenth century by telling us that we should *involve* our (pharmacy) students more in education so they really can learn how to become more complete professionals.

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SUMMARY

Summary

Since it is impossible these days to imagine pharmacy without *Pharmaceutical Care*, the role of a pharmacist has changed from a more drug-oriented to a more patient-oriented role during the last decade. This is one of the reasons pharmaceutical higher education had to be modified to answer to the new needs of a today's pharmacist. Another reason instructional changes have been carried out is the fact that the Bologna Declaration (1999) instigated a complete turn-over in the higher educational landscape. Therefore pharmaceutical academic institutions had to adapt their curriculum not only in view of the content of the courses but also in view of applying new educational techniques and implementing the Bachelor -Master structure.

At the Faculty of Pharmaceutical Sciences of the Ghent University they decided to implement new ways of teaching like problem-based learning, task-based learning and case-based learning. In the fifth or the last year of the curriculum a whole new course, called "Integrated Pharmaceutical Knowledge" (IPK) was installed parallel with the internship. This IPK course uses a computer-supported collaborative learning environment (CSCLE) to present patient cases to the student, who have to find in little groups answers to problems related to the presented cases. Since these students are fulfilling their internship at diverse places during the last three months of their last curriculum year, they can easily discuss on-line via the CSCLE.

The main aim of this dissertation was to investigate whether these educational renewals in general and the implementation of a new course in particular had an impact on students' readiness for internship or professional life in a pharmacy, mainly a community pharmacy.

To study this, we first designed a survey to present to the students. This questionnaire was called the Internship Experience Scale (IES) and was based on the adapted final attainment levels and the goals of internship. As study of this IES revealed that it is a reliable and valid instrument, we can use this instrument to measure the possible impact of the mentioned instructional adaptations.

The instrument was filled in by the last year's students during 5 successive years and this provided us with enough information to study the longitudinal impact of the IPK course and the other

educational renewals. The results of the longitudinal study demonstrated that students over time achieved better the adapted final attainment levels and goals. There could also be seen an impact of the implementation of the IPK course, but only in the academic year it was officially entered in the curriculum and in the academic year in which the course was adjusted.

As educational research in the near past already stated that, when using a CSCLE, assigning students with roles during their on-line discussions could have a beneficial impact, although not all studies reveal the same results, it was interesting to carry out some research in this area. We decided to investigate the impact of role assignment and of the pharmaceutical nature or content of the patient case on the level of knowledge construction (LKC) and on the integrated curriculum score, a standardised score concerning the content of the provided answers of the students. Although we learned that role assignment had no significant impact, except for the students who had to summarize all the answers, it was obvious that the on-line discussions in the groups where students were assigned with roles passed off more smoothly. Looking at these results, we decided to implement from that moment on (academic year 2005-2006) role assignment for the on-line discussions during the IPK course. The nature or content of the case had a significant influence, thus there was decided to pay even more attention to the content of the presented patient cases.

In the described researches, only the impact of the instructional changes was being investigated, but we never asked ourselves the question if the individual student characteristics had a predictive effect on the mentioned results. So it would be intriguing to find out whether the possible initial differences between the students would cause also a difference in achieving a different level of knowledge construction or a different content score considering the answers giving during the on-line discussions of the IPK course. We looked at individual student characteristics like gender, level of prior knowledge but also the way a student performed his/her role and the amount of contributions he/she obtained were taking into account. After this particular research we could conclude that the mentioned background variables didn't have a predictive effect on the impact of the IPK course concerning the LKC and the level of integrated knowledge. This means that our IPK course is able to provide every student of the last year with the "same" information and that initial differences between the students fade away.

The overall conclusion of this dissertation is positive. The adapted educational renewals at the Faculty of Pharmaceutical Sciences of the Ghent University were able to prepare our students better for their internship and for the changed profession of a pharmacist. In particular, we can conclude that, if designing and developing of a course is supported by reliable educational research, we are able to construct new courses that use the modern instructional technologies in a constructive way.

SAMENVATTING

Samenvatting

Aangezien *Farmaceutische Zorg* de laatste jaren de farmaceutische wereld in zijn greep heeft, is de rol van de apotheker tegenwoordig verschoven van een meer geneesmiddelgerichte naar een meer patiëntgerichte rol. Om een antwoord te geven aan deze nieuwe invulling van het beroep van apotheker, moest het farmaceutisch hoger onderwijs inhoudelijke aanpassingen doorvoeren. Maar dit was echter niet de enige reden. Na de Bologna-verklaring in 1999 werden alle Europese ondertekenaars verplicht om hun hoger onderwijs op elkaar af te stemmen. Dit zorgde niet enkel voor de ingrijpende Bachelor-Master invoeringen, maar ook voor het invoeren van nieuwe en meer moderne onderwijstechnieken.

Aan de Faculteit Farmaceutische Wetenschappen van de Universiteit Gent heeft men bijgevolg beslist om nieuwe onderwijsvormen te implementeren zoals probleem-gestuurd leren, taak-gericht leren en casus-gericht leren. Deze onderwijsvormen werden algemeen over het hele curriculum verspreid ingevoerd. In het vijfde of laatste jaar echter werd een volledig nieuwe cursus, nl. "Geïntegreerde Farmaceutische Kennis" (GFK) complementair aan de stage ingevoerd. Deze GFK-cursus maakt gedeeltelijk gebruik van computer-ondersteund samenwerkend leren om patiëntcasussen aan de studenten aan te bieden. De studenten moeten in kleine groepjes een gemeenschappelijk antwoord formuleren op de vragen die gerelateerd worden aan de bewuste casussen. Aangezien de studenten tijdens de laatste drie maanden van het academiejaar op zeer uiteenlopende plaatsen stage lopen, biedt de elektronische leeromgeving, waar de studenten online kunnen discussiëren over de aangereikte casussen de ideale oplossing.

De belangrijkste onderzoeksvraag van dit doctoraatsonderzoek is de volgende: "Kunnen wij onderzoeken of de invoering van nieuwe en moderne onderwijstechnieken in het algemeen en het nieuwe vak GFK in het bijzonder een impact heeft op de startbekwaamheden van een stagiair of een startende apotheker, voornamelijk dan een officina apotheker?".

Om dit te kunnen onderzoeken, werd er eerst een vragenlijst of instrument ontworpen op basis van de aangepaste eindtermen van de opleiding farmacie en op basis van de doelstellingen van de stage. Dit instrument werd de "Stage Ervarings Maatstaf" (SEM) genoemd. Gedetailleerde studie van dit instrument bracht aan het licht dat we hier kunnen spreken van een betrouwbaar en geldig

instrument. Er is bijgevolg geen enkel probleem om het te gebruiken om informatie te bekomen in verband met de startbekwaamheden van de laatstejaarsstudenten.

Het instrument werd gedurende vijf opeenvolgende academiejaren ingevuld door de studenten van het laatste jaar en gaf ons op die manier voldoende informatie om de impact op langere termijn van de onderwijskundige aanpassingen te onderzoeken. De resultaten van deze longitudinale studie lieten uitschijnen dat studenten tegenwoordig, door die invoering van veranderingen in het onderwijs in het algemeen en de GFK-cursus in het bijzonder, beter zijn voorbereid om in het professionele leven te stappen. De individuele impact van de GFK-cursus bleek enkel significant in het academiejaar dat het vak officieel werd ingevoerd (2004-2005) en in het academiejaar dat er grondige veranderingen aan GFK werden doorgevoerd (2005-2006). Dit was zoals we verwacht hadden.

Aangezien onderwijskundig onderzoek in het nabije verleden al had aangetoond dat het toekennen van rollen tijdens een online discussie een positieve invloed kan hebben op de discussie, ondanks het feit dat niet alle onderzoeken hetzelfde concluderen, was het interessant om de impact van het toekennen van rollen ook in onze farmaceutische setting te onderzoeken. Het onderzoek naar de impact van rollen en de invloed van de inhoud van de casussen op het niveau van kennisconstructie en op het behalen van een geïntegreerde curriculumscore, een gestandaardiseerde score die aanduidt in hoeverre de inhoud van de antwoorden op de gestelde vragen bij de casussen correct is, werd uitgevoerd. Ondanks het feit dat uit dit onderzoek bleek dat rollen geen significante invloed hadden, uitgezonderd de rol van de samenvatter, was het toch duidelijk dat de discussies in de groepen waar studenten rollen kregen toebedeeld veel vlotter verliepen. Bijgevolg werd er beslist om vanaf dan (vanaf academiejaar 2005-2006) rollen in te voeren tijdens de online discussies. Een ander resultaat van dit onderzoek was dat de inhoud van de casus wel degelijk een significante invloed had op het behaalde niveau van kennisconstructie en van geïntegreerde farmaceutische kennis. Bijgevolg werd er op dit gebied dan ook beslist om nog meer aandacht te schenken aan het samenstellen van de casussen en bijbehorende probleemstellingen.

In de hierboven vermelde onderzoeken werd er alleen gekeken naar de impact van de instructieveranderingen, zowel op algemeen als op specifiek GFK-niveau. Er werd echter nog geen rekening gehouden met de individuele karakteristieken van de student en met het feit dat deze ook wel eens een invloed zouden kunnen hebben op het behalen van een niveau van kennisconstructie of geïntegreerde kennis. Tijdens een laatste onderzoek richtten we ons dan ook op de individuele studentkarakteristieken en onderzochten of geslacht en/of voorkennis een voorspellend effect

kunnen hebben op het behalen van een welbepaald niveau van kennisconstructie of geïntegreerde farmaceutische kennis. Maar er werd ook gekeken naar de invulling van de toebedeelde rol en naar het gemiddeld aantal constructieve bijdragen per casus van de studenten en er werd onderzocht of deze mediërende variabelen ook een voorspellend effect zouden kunnen hebben. De resultaten waren zoals we hoopten, de mogelijke onderlinge individuele verschillen bij het begin van het laatste jaar zijn zeker niet meer terug te vinden op het einde, wanneer we kijken naar het behaalde niveau van kennisconstructie en van geïntegreerde farmaceutische kennis. Dit betekent bijgevolg dat onze GFK-cursus aan iedereen de mogelijkheid biedt om zich op een gelijkwaardige manier verder te scholen en zijn/haar startbekwaamheden voor het professionele leven verder te ontwikkelen, de initiële individuele verschillen vlakken dus af.

We kunnen bijgevolg stellen dat de algemene conclusie van deze thesis positief is. We hebben ingezien dat we in staat zijn om zelf nieuwe constructieve opleidingsonderdelen te ontwikkelen die gebruik maken van de moderne technologieën, zolang we er maar onderwijskundig onderzoek aan koppelen. Maar belangrijker is, de aangebrachte onderwijskundige vernieuwingen aan de Faculteit Farmaceutische Wetenschappen van de Universiteit Gent zijn erin geslaagd om onze afgestudeerde studenten beter voor te bereiden op de veranderde rol van de apotheker.

APPENDIX: Internship Experience Scale as used in this dissertation

| | Ample sufficient | Sufficient | Insufficient | Ample insufficient | Needless point of consideration during internship |
|---|------------------|------------|--------------|--------------------|---|
| | | | | | |
| I have got enough insight in the division in a pharmacy during my higher education. | | | | | |
| I have learned enough during my higher education about the administration in view of the staff. | | | | | |
| I have learned enough about controlling incompatibilities of a magistral preparation during my higher education. | | | | | |
| I have learned enough about the legislation of the different medicines during my higher education. | | | | | |
| I have learned enough about the provisions for weekend and night service during my higher education. | | | | | |
| I have learned enough during my higher education about controlling the administrative data of a prescription. | | | | | |
| I have learned enough during my higher education about providing information concerning the literature that can be consulted. | | | | | |
| I have learned enough about the identification of raw materials during my higher education. | | | | | |
| I have learned enough during my higher education about the association with the division of labour in a pharmacy. | | | | | |
| I have learned enough during my higher education about controlling the maximal dose of the medicines on a prescription. | | | | | |
| I have got enough information about the existing literature concerning the making of and the problems related to magistral preparations during my higher education. | | | | | |
| I have learned enough during my higher education about controlling a prescription on instructions for use of medicines during my higher education. | | | | | |
| I have learned enough during my higher education about controlling a prescription on incompatibilities. | | | | | |

| | | | | | |
|---|--|--|--|--|--|
| I have learned enough during my higher education about the deontology of relationships with colleagues. | | | | | |
| I have learned enough about the legal regulations concerning prescriptions during my higher education. | | | | | |
| I have learned enough about the systematic way of dealing with a magistral preparation during my higher education. | | | | | |
| I have learned enough about controlling a prescription on the dosages during my higher education. | | | | | |
| I have learned enough during my higher education about the legal aspects concerning administration of narcotics. | | | | | |
| I have learned enough about managing the stock during my higher education. | | | | | |
| I have learned enough about the accountancy of a pharmacy during my higher education. | | | | | |
| I have learned enough about the choice of excipients of magistral preparations during my higher education. | | | | | |
| I have learned enough about controlling the process of magistral preparations during my higher education. | | | | | |
| I have learned enough during my higher education about the necessity of dedication for the interests of the profession of pharmacist. | | | | | |
| I have learned enough about the choice of the right equipment for magistral preparations during my higher education. | | | | | |
| I have learned enough during my higher education about the interactions of the different medicines. | | | | | |
| I have learned enough about matching the right labels on magistral preparations during my higher education. | | | | | |
| I have learned enough about OTC-products during my higher education to adapt to the ways of self-medication of the patients. | | | | | |
| I have learned enough during my higher education about the indications of the different medicines. | | | | | |
| I have learned enough to make the right decision about packaging magistral preparations during my higher education. | | | | | |

| | | | | | |
|---|--|--|--|--|--|
| I have learned enough about the toxicity of the different medicines during my higher education. | | | | | |
| I have learned enough during my higher education about the legal aspects concerning prescriptions. | | | | | |
| I have learned enough about the use of the different medicines during my higher education. | | | | | |
| I have learned enough during my higher education about the personnel policy. | | | | | |
| I have learned enough about the storage of the different medicines during my higher education. | | | | | |
| I have learned enough about the legislation concerning labels on magistral preparations during my higher education. | | | | | |
| I have learned enough about bandages and related materials for medical nursing during my higher education. | | | | | |
| I have learned enough during my higher education to provide the patients with enough instructions and advice. | | | | | |
| I have learned enough about "Pharmaceutical Care" during my higher education. | | | | | |
| I have learned enough during my higher education about controlling the delivery of prescribed medicines. | | | | | |
| I have learned enough during my higher education about the deontological relationship with doctors. | | | | | |
| I have learned enough about contacting the wholesalers and representatives during my higher education. | | | | | |
| I have learned enough during my higher education about the value of further training courses and life-long learning. | | | | | |
| I have learned enough about controlling a magistral preparation after being prepared during my higher education. | | | | | |
| I have learned enough during my higher education about professional confidentiality and ethics. | | | | | |
| I have learned enough about the purchasing policy during my higher education. | | | | | |
| I have learned enough during my higher education about the economic aspects of the professional pharmaceutical world. | | | | | |

| | | | | | |
|---|--|--|--|--|--|
| I have learned enough during my higher education about the refund policy of medicines in our health care system. | | | | | |
| I have learned enough to calculate the price of magistral preparations during my higher education. | | | | | |
| I have learned enough about controlling the dose of magistral preparations during my higher education. | | | | | |
| I have learned enough about the side effects of the different medicines during my higher education. | | | | | |
| I have learned enough about producing the right protocol for a magistral preparation during my higher education. | | | | | |
| I have learned enough about the purchasing policy of raw materials for preparing magistral preparations during my higher education. | | | | | |
| I have learned enough during my higher education about social security and social legislation. | | | | | |

CURRICULUM VITAE

Personal information

Name: Timmers

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Formation

- | | |
|--------------------|---|
| 2002 – 2008 | PhD student at the Laboratory of Drug Analysis |
| 1995 – 2000 | Pharmacist, Vrije Universiteit Brussel |
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Work experience

2009 Full-time assistant academic staff member with the responsibility of the course “Integrated Pharmaceutical Knowledge” (2nd Master) and responsible for design and development of an integrated practical course (3rd Bachelor).

2002 – 2008 Full-time member of the academic staff and educational researcher at the Department of Pharmaceutical Analysis, Laboratory of Drug Analysis (Prof. Dr. W.R.G. Baeyens), Ghent University.

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Co-organisator of the Internship Exam in the last year of the Curriculum of Pharmaceutical Sciences (electronic multiple choice-exam), academic year 2006-2007, 2007-2008

Design, implementation and supervision of an innovative sort of graduate theses (master theses): pharmaceutical and integrated case-based studies, since 2004

Initiator (2003) for the preliminary investigation to finally implement the course “Integrated Pharmaceutical Knowledge” in the last year of the Pharmaceutical Curriculum, Ghent University

First author of 5 publications in international peer-reviewed scientific journals and co-author of a publication in an international peer-reviewed journal

*Design and Development of an Instrument to Measure Internship Readiness of Last Year’s Pharmacy Students, American Journal of Pharmaceutical Education-submitted 2009
(S. Timmers, W.R.G. Baeyens and M. Valcke)*

Longitudinal and Cross-Sectional Study of the Impact of a Curriculum Innovation in a Pharmacy University Programme, Medical Education – submitted 2009
(S. Timmers, M. Valcke and W.R.G. Baeyens)

Exploring the Predictive Effect of Individual Student Characteristics on the Level of Knowledge Construction and the Level of Integrated Pharmaceutical Knowledge in a Computer-Supported Collaborative Learning Environment: an Analysis, Medical Teacher – submitted 2009
(S. Timmers, H. Van Keer, T. Schellens, W.R.G. Baeyens and M. Valcke)

CSCLE and Internships of Pharmacy Students - The Impact of Computer Supported Collaborative Learning on Internship Outcomes of Pharmacy Students.
International Journal of Interactive Learning Environments, 16(2), 131-141 (2008).
(S. Timmers, M. Valcke, K. De Mil & W.R.G. Baeyens)

Collaborative Learning and ICT: The Flemish Experiences, Educational Technology Magazine, 45 (5), 13-17 (2005).
(M. Valcke, K. Chiliza, M. De Smet, B. De Wever, T. Schellens, S. Timmers and H. Van Keer)

Newer Analytical Chemistry Teaching Approaches at the Pharmaceutical Faculty of the Ghent University, Mikrochimica Acta, Vol. 142, nr 3/2003
(S. Timmers, W.R.G. Baeyens, J.-P. Remon and H. Nelis)

Other publications

Future Education of Community Pharmacists, a part of the article “EAFP Annual Conference, 20-21 September 2007, Madrid, Spain, Looking at community pharmacists' training through a PGEU perspective”, Pharmacy Education, 8 (1), 85 (2008)
(W.R.G. Baeyens and S. Timmers)

The Impact of a New Educational Technique on Internship Outcomes of Pharmacy Students, a part of the article “EAFP Annual Conference, 20-21 September 2007, Madrid, Spain, Looking at community pharmacists' training through a PGEU perspective”, Pharmacy Education, 8 (1), 83-85 (2008).
(S. Timmers and W.R.G. Baeyens)

An Interview “How Do Universities Find an Answer to the New Needs of a Modern Pharmacistr? Ghent University: Internship with Integrated Pharmaceutical Knowledge.”, Apothekersblad july-august 2007, interviewer: Erik Beerten.

Project OPL1 “Guided Program for Self-Study Complementary to the Pharmacy Internship.”, 10 years of Educational Innovation at the Ghent University: An Overview of the projects, p. 61-63 (2007).

Author of an educational project

Author of the project “Internship and Integrated Pharmaceutical Knowledge”, in view of the Projects “Open Parallele Leerwegen

2004", that was approved within the Educational Development Vision of the Ghent University in January 2005 and for this 90 000 Euros were available for the Faculty of Pharmaceutical Sciences for the recruitment of a fulltime staff member

Oral presentations of research results on international congresses and meetings

Longitudinaal Onderzoek van de Impact van een Curriculuminnovatie binnen de Farmaceutische Wetenschappen aan de Universiteit Gent, presentation at the "Nederlands-Vlaamse Farmacie Onderwijsdag", Utrecht, Nederland, the 25th of May 2009.

(S. Timmers, M. Valcke and W.R.G. Baeyens)

New Ways of Teaching: the Example of Pharmacy, presentation in view of an international series of lessons according to "State of Play of Training Policy" organised by the European Research Centre for Reference Materials and Measurements in order of the European Commission, Brussels (in video-contact with Sevilla, Ispra, Karlsruhe and Geel), Charlemagne building of the European Commission, the 12th of November 2008

(S. Timmers, W.R.G. Baeyens)

The Impact of a New Educational Technique on Internship Outcomes of Pharmacy Students, Abstracts book of the 2007 Annual Conference "Trends in Pharmacy Education, From Subject Orientation to Goals and Objectives", Faculty of Pharmacy, Complutense University (UCM), Madrid, Spain, the 20th-22nd of September 2007; organisation: European Association of Faculties of Pharmacy, p. 35.

(S. Timmers, W.R.G. Baeyens)

New Teaching Approaches in Pharmaceutical Sciences, Program and Abstracts Book of the "10th Forum of Pharmaceutical Sciences", Faculté de Pharmacie, Université de Montréal, Montréal (Canada), the 5th of May 2001; organisation: BGFW (Belgisch Genootschap voor Farmaceutische Wetenschappen), p. C44;

(S. Timmers, A. Van den Berge en W.R.G. Baeyens)

Oral presentation on a national congress

Internship and Integrated Pharmaceutical Knowledge, Day of Educational Renewals of the Ghent University, 10th of May 2007, organisation: Department of Education Quality Assurance of the Ghent University in cooperation with the OPL working group (Open Parallele Leerwegen) and DKB projects (Digitale Kennisbestanden), (co-presentation S. Timmers and M. Dhondt)

Oral presentation by a co-author

Novel Educational Techniques versus Internship Outcomes of Pharmacy Students at the Ghent (Flanders) University, Invited Lecture at the Faculty of Pharmaceutical Sciences, Fukuoka University (Japan), (prof. Dr. Kenichiro Nakashima), the 10th of July 2008

(W.R.G. Baeyens, S. Timmers)

Lifelong Learning of Community Pharmacists: Belgian Ambitions in a European Perspective, Invited lecture at the Faculty of Pharmaceutical Sciences, Nagasaki University (Japan), (Prof. Dr. Kenichiro

Nakashima), the 7th of July 2008
(W.R.G. Baeyens, S. Timmers)

Newer Educational Techniques and Internship Training of Pharmacy Students at the Ghent University, Invited Lecture at the Charles University, Prague, Faculty of Pharmacy (Prof. Dr. Petr Solich), Tsjechië, 16th – 19th of March 2008
(S. Timmers and W.R.G. Baeyens)

The Renewal of Analytical Chemistry Teaching, Program and Abstracts Book of the First Joint Meeting “Education in Analytical Chemistry”, Córdoba (Spain), 14th – 15th of September 2001, organisation and sponsors: Ministry of Science and Technology, Consulate of Education and Science of the Embassy of Andalusia, University of Córdoba, Spanish Community of Analytical Chemistry, chairman Prof. Dr. M. Valcárcel
(S. Timmers, W.R. G. Baeyens, J.-P. Remon en H. Nelis)

Poster presentations

The Impact of a New Educational Technique on Internship Outcomes of Pharmacy Students, Abstracts book of the 2007 Annual Conference “Trends in Pharmacy Education, From Subject Orientation to Goals and Objectives”, Faculty of Pharmacy, Complutense University (UCM), Madrid, Spain, 20th-22nd of September 2007; organisation: European Association of Faculties of Pharmacy, p. 35.

(S. Timmers, W.R.G. Baeyens)

Integrated Pharmaceutical Knowledge, Educational Renewals Day of the Ghent University, 10th of May 2007, organisation: Department of Education Quality Assurance of the Ghent University in cooperation with the OPL working group (Open Parallelle Leerwegen) and DKB projects (Digitale Kennisbestanden),

(S. Timmers, M. Dhondt, H. Nelis, W. Baeyens, J.P. Remon)

Information and Communication Technology in Pharmaceutical Sciences: a New Trend in Education, Program and Abstracts Book of the Conference on “New Orientations of Teaching Science and Practice”, Faculty of Medicine and Pharmacy, Vrije Universiteit Brussels, 4th-6th of May 2001; organisation: The European Association of Faculties of Pharmacy and the VUB, Chairman Prof. Dr. B. Rombaut, p. P8

(S. Timmers, A. Van den Berge en W.R.G. Baeyens)

Participation at several other national and international congresses, workshops and symposia

Workshop “Hands-on Implementation of Process Analytical Technology (PAT) Systems in Production Processes”, Novotel gent, organisation: PAT-group of the Faculty of Pharmaceutical Sciences, Ghent University, 25th-26th of August 2008

Conference on “Trends in Pharmacy Education, From Subject Orientation to Goals and Objectives”, Faculty of Pharmacy, Complutense University (UCM), Madrid, Spain, 20th-22nd of September 2007; organisation European Association of Faculties of Pharmacy

Day of Educational Renewals, Campus Jette, Vrije Universiteit Brussels, organisation: University Association Brussels, 5th of June 2007

*Workshop "Good-practices day, E-learning", Hogeschool Ghent, organisation: Association Ghent University, 23rd of May 2007
Day of Educational Renewals of the Ghent University, Het Pand, Ghent University, 10th of May 2007*

Workshop "Multiple Choice Exam via Curios", Sterre, Direction ICT (instructor: Toon Van Hoecke), 8th of May 2007

Workshop "Multiple Choice Exam", Het Pand, Ghent University (Luc Van de Poele, Elien Sabbe), 24th of April 2007

Workshop "The Feedback Conversation", Het Pand, Ghent University (Luc Van de Poele, Elien Sabbe, Catherine Malfait), 5th-6th of December 2006

Workshop "Digital Didactics", Vliebergh-Sencie centre, K.U.Leuven, 14th of September 2006

Educational Research Days 2005 "Measuring and Educational Research", Ghent University, Department of Didactics, 30th of May and 1st of June 2005

*Symposium "Technology in the Learning Process: Visions for Today and Tomorrow.", organisation ICT&O Expertise centre (Ghent University), 3rd of March 2005, Het Pand, Ghent
Workshop "Lion meets Dragon", Genetic Polymorphisms and Vitamin Metabolism: Biochemical Aspects, Anthropological and Historical Consequences, Holiday Inn Flanders Expo, Ghent, 6th of October 2004*

Presentation of the Compendium of GEWICT (Gezondheid en Welzijn met ICT), Provincial Administrative Centre, Ghent, 16th of May 2003

Workshop "Doing a PhD at the Ghent University", Faculty of Pharmaceutical Sciences, Ghent University, Ghent, 12th of May 2003

Day of Science, Department of Internal Medicine in cooperation with the Faculty of Medicine and Health Sciences, Ghent University, Auditorium UZ Gent, 17th January 2003

Drug Analysis 2002, congress centre Oud Sint-Jan, Bruges, 21st 2002

10th Forum of Pharmaceutical Sciences, Faculté de Pharmacie, Université de Montréal, Montréal (Canada), 24th-25th of May 2001; organisation: Belgian Commission for Pharmaceutical Sciences

Conference on "New Orientations of Teaching, Science and Practice ", Faculty of Medicine and Pharmacy, Vrije Universiteit Brussels, 4th-6th of May 2001; organisation: The European Association of Faculties of Pharmacy and VUB

Responsible for the organisation and/or guidance of several practical courses for pharmacy students

Instrumental Analytical Chemistry, Practical Exercises, 3rd Bachelor year in Pharmaceutical Sciences (academic year 2006-2007, 2007-2008)

Drug Analysis, Practical Exercises (3rd Bachelor year in Pharmaceutical Sciences) (45 h/student) (academic year 2004-2005 and 2005-2006)

Drug Analysis, Practical Exercises (3rd year of the curriculum of Pharmaceutical Sciences) (60h/student), Academic year 2003-2004

Responsible for the implementation of novel educational strategies

Supervisor and coach of 12 graduate theses

Supervisor and coach of the thesis: "A Case study: Lactose Intolerance, an Extensive Pharmaceutical Study", Heleen Van Hove, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2007-2008

Supervisor and coach of the thesis: "A Case study: Haemolytic Anaemia, an Extensive Pharmaceutical Study", Laure Geslin, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2006-2007

Supervisor and coach of the thesis: "A Case study: Respiratory Sincitial Viral and other Viral Infections of Babies, an Extensive Pharmaceutical Study", Julie Ostyn, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2006-2007

Supervisor and coach of the thesis: "A Case study: Heart and Coronary Diseases, an Extensive Pharmaceutical Study", Anneleen Van der Jeught, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2006-2007

Supervisor and coach of the thesis: "A Case study: Topical Treatments for Acne, an Extensive Pharmaceutical Study", Sarah Haentjens, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2006-2007

Supervisor and coach of the thesis: "A Case study: Psoriasis, an Extensive Pharmaceutical Study", Geertrui Van der Cruyssen, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2006-2007

Supervisor and coach of the thesis: "A Case study: Chronic and Obstructive Pulmonary Diseases, an Extensive Pharmaceutical Study", Aline Vanhie, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2005-2006

Supervisor and coach of the thesis: "Moderate and Evaluate Online Discussions in view of the Course Integrated Pharmaceutical Knowledge", Kaatje De Mil, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2005-2006

Supervisor and coach of the thesis: "A Case study: Diabetes, an Extensive Pharmaceutical Study", Céline Cattoir, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2004-2005

Supervisor and coach of the thesis: "Integrated Pharmaceutical Knowledge: A Case study", Marie-Hélène Van Quickenborne, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2003-2004

Supervisor and coach of the thesis: "Educational Renewals at the Faculties of Pharmaceutical Sciences: Pedagogical versus Academic Efficiency", Wilhelm Mortier, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2003-2004

Supervisor and coach of the thesis: "Use and Analysis of the latest anti-cholesterol medicines", Ben Janssen, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2002-2003

Other educational activities

Co-organisator of the "Case studies" (via the electronic learning environment, organising the online fora for discussing these cases) during the Deontological Session for the last years' students, Faculty of Pharmaceutical Sciences, Ghent University, the 18th of April 2008

Coach of students of second year's students at the Faculty of Pharmaceutical Sciences in view of the course "Scientific Communication", academic year 2007-2008

Organising computer support during the thesis presentations of the fourth year's students, June 2004, 2005, 2006, 2007

Co-organizer and teacher of several symposia and training courses

Co-organising and designing of the website for the workshop "Hands-on Implementation of Process Analytical Technology (PAT) Systems in Production Processes", Novotel Ghent, organisation: PAT-group of the Faculty of Pharmaceutical Sciences of the Ghent University in co-operation with EUFEPS, 25th-26th of August 2008

Co-author and teacher of lessons in view of the project "Over the Counter Medicines with Advice" (Ghent, Antwerp, Kortrijk, Bruges and Brussels), a project organised by the Belgian professional organisations for pharmacists in cooperation with the Belgian Faculties of Pharmaceutical Sciences and the Pharmaceutical Industry, the lessons concerned cough, eye disorders and stomach and intestinal disorders, 2008

Co-organising of the workshop "Lion meets Dragon", Genetic Polymorphisms and Vitamin Metabolism: Biochemical Aspects, Anthropological and Historical Consequences, Holiday Inn Flanders Expo, Ghent, 6th of October 2004

Maintenance of the departmental website

Administrator and responsible of the website of the Laboratory of Drug Analysis, since 2007

Professional memberships

Member of the working group "Educational Renewals (concerning the design and development of an innovative course in the third Bachelor year in view of integrating most basic courses", Faculty of Pharmaceutical Sciences, Ghent University, 2008

Member of the Association Research Group of Departments of Health Sciences, in view of educational research, since 2007

Member in the Committee of the Doctoral Schools of Life Sciences and Medicine since October 2007

Member of the Environment Committee of the Faculty of Pharmaceutical Sciences, Ghent University, since October 2007

Member of the Educational Committee at the Faculty of Pharmaceutical Sciences, Ghent University, since October 2006

Member of the OPL-working group (Open Parallelle Leerwegen) starting at the beginning of 2006, a working group who has interests in educational renewals at the Ghent University

Belgian Society of Pharmaceutical Sciences (BGFW), since 2000

Logistic activities

Co-organising the new timetable for the educational courses for the academic year 2005-2006 and 2006-2007 in view of the Bachelor-Master educational reform

Organising a desk for giving information concerning Educational Renewals during the open house day of the Faculty of Pharmaceutical Sciences, March 2006, March 2007

Design and development of two posters on the subject of Educational Renewals, March 2006, in view of the open house day of the Faculty of Pharmaceutical Sciences (Timmers S., Dhondt M., Mehuys E., Sanders N. ; Nieuwe Onderwijsvormen Faculteit Farmaceutische Wetenschappen)

Organising the arrangements of the practical exercises for the Faculty of Pharmaceutical Sciences, academic year 2004-2005

Organising an ICT-desk during the open house day of the Faculty of Pharmaceutical Sciences, March 2003, March 2004, and February 2005

2000-2001

Fulltime member of the scientific staff and ICT-co-ordinator at the Department of Pharmaceutical Analysis, Laboratory of Drug Analysis (Prof. Dr. W.R.G. Baeyens), Ghent University

Design and development of computer-aided tests (program "Question Mark Designer") as part of the practical exercises of the course "Analytical Chemistry I", 2nd year of the education of Pharmaceutical Sciences, Ghent University, academic year 2000-2001

Design and development of a website for second years' students at the Faculty of Pharmaceutical Sciences, Ghent University, academic year 2000-2001

Author of an educational project

Author and promoter of the interuniversity project STIHO (Stimuleren Innovatie Hoger Onderwijs) "Interuniversity Project that deals with Integrated Knowledge of medicines under the authority of the Faculties of Pharmacy in Flanders, Belgium", 2001

Membership

Member of the ICT-group of the Faculty of Pharmaceutical Sciences, Ghent University

Supervisor and coach of a graduate thesis

Supervisor and coach of the thesis: "Developments of ICT in the Pharmaceutical Educational Institutions. Reality or Fiction?", Filip De Groeve, 4th year student, Faculty of Pharmaceutical Sciences, Ghent University, academic year 2000-2001

2000

Pharmacist in a community pharmacy, Apotheek Gielen, Houthalen (2 months)